GEOLOGIC
DATA REPORTS

Book 4 of 4

Attachments to PG&E Letter DIL-01-004
Dated December 21, 2001

DATA REPORT J

PETROGRAPHIC ANALYSIS AND X-RAY DIFFRACTION OF ROCK SAMPLES (SPECTRUM PETROGRAPHICS, INC.) DIABLO CANYON ISFSI

PREPARED BY		DATE	11/5/01
	Jeff L. Bachhuber		William Lettis & Associates, Inc.
	Printed Name		Organization
VERIFIED BY		DATE	
	Scott C. Lindvall		William Lettis Associates204
	Printed Name		Organization
APPROVED BY		DATE	11/5/01.
	William D. Page		PG&E Geosciences Dept.
	Printed Name		Organization

REGISTERED GEOLOGIST
JEFF BACHHUBER
4909
STATE OF CALIFORNIA

DATA REPORT J

PETROGRAPHIC ANALYSIS AND X-RAY DIFFRACTION OF ROCK SAMPLES (SPECTRUM PETROGRAPHICS, INC.) DIABLO CANYON ISFSI

PREPARED BY		DATE	11/5/01
	Jeff L. Bachhuber Printed Name		William Lettis & Associates, Inc. Organization
VERIFIED BY		DATE	11/5/01
	Scott C. Lindvall Printed Name		William Lettis Associates, Inc. Organization
APPROVED BY		DATE	
	William D. Page Printed Name		PG&E Geosciences Dept. Organization

REGISTERED GEOLOGIST
JEFF BACHHUBER
4900
STATE OF CALIFORNIA

DATA REPORT J
PETROGRAPHIC ANALYSIS AND X-RAY DIFFRACTION OF ROCK SAMPLES (SPECTRUM PETROGRAPHICS, INC.) DIABLO CANYON ISFSI

Table of Contents

Page

1.0 Introduction J-3

2.0 Methodology J-3

3.0 Results J-4

4.0 References J-5

List of Tables

Table J-1 Petrographic Analysis of Rock Samples Taken from Outcrops

Table J-2 Petrographic Analysis of Rock Samples from Borings in ISFSI Site Area

Table J-3 X-Ray Diffraction Analysis of Rock Samples from Borings in ISFSI Site Area

List of Figures

Figure J-1 1998 Petrographic Sample Locations from Surface Exposures

Figure J-2 2001 Petrographic Sample Locations from Boreholes

List of Attachments

Attachment 1 Spectrum Petrographics, Inc., Report entitled "Diablo Canyon DCSF Petrographic Report #HSI", dated October 13, 1998.

Attachment 2 Spectrum Petrographics, Inc., Report entitled "DCPP ISFSI Site Project Petrographic Report #LBN", dated June 27, 2001.

Attachment 3 Spectrum Petrographics, Inc., X-ray Diffraction Analysis Data of Rock Samples at the DCPP ISFSI Site.

DATA REPORT J
PETROGRAPHIC ANALYSIS AND X-RAY DIFFRACTION OF ROCK SAMPLES (SPECTRUM PETROGRAPHICS, INC.) DIABLO CANYON ISFSI

1.0 INTRODUCTION

Spectrum Petrographics, Inc. (Spectrum) provided petrographic analyses of thirteen rock samples collected in 1998 from surface outcrops at the Diablo Canyon ISFSI site by geologists Patrick Drouin, Gary Simpson, and Jeff Bachhuber of William Lettis & Associates, Inc. (WLA). Samples of core from borings in the ISFSI site area were also selected for petrographic analyses by Jeff Bachhuber of WLA in 2001 at the direction of William Page of PG&E Geosciences Department. Geologic mapping based in part on the results of petrographic analyses is presented in Diablo Canyon ISFSI Data Report A. The data on the borings at the ISFSI site area are provided in Diablo Canyon ISFSI Data Report B. The analyses performed by Spectrum help identify the mineralogy and rock types in the ISFSI site area. Petrographic reports in this Data Report include the rock name, visual estimates of mineral abundances, and brief descriptions of rock textures.

The preparation of this data report was performed under the WLA Work Plan (Rev. 2) dating November 28, 2000 using data collected under that Work Plan and a second WLA Work Plan (Rev. 1) dated September 19, 2001.

2.0 METHODOLOGY

Rock specimens considered to be representative of the rocks in the ISFSI site area were collected from outcrops (13 samples) and core (23 samples) at and near the ISFSI site

(Figure J-1). Each rock sample was first examined in hand specimen. Spectrum prepared 27 X 46 mm–format thin sections finished by standard lapping techniques, and then, Spectrum examined the thin sections with a petrographic microscope under plane-polarized and cross-polarized light with magnification that ranged from 3X to 114X. Photographs and/or photomicrographs were taken to document each rock sample.

X-ray diffraction was performed on crushed rock made from 10 selected samples to obtain more precise assessment of the mineralogy in the rocks. The clay fraction on two samples was separated and also analyzed.

3.0 RESULTS

Thirty-six petrographic descriptions identify the mineral constituents, textures, and degree of alteration of each rock sample. These are summarized on Tables J-1 and J-2 that also show the classification of the rocks used in the geologic mapping (Data Report A). The sedimentary rock types identified from the outcrops include clayey dolomite, clayey fossiliferous dolomite and limestone, and altered (friable) sandstone and these designations generally are used in the mapping. The percentage of carbonate grains ranged from 40 to 90 percent (Table J-1). The rock types identified from the core samples are altered clayey carbonate, siltstone, claystone, bioclastic limestone, and calcareous claystone (called dolomite and friable dolomite in the geologic mapping) and altered sandstone, sandy carbonate, and clayey carbonate (called sandstone and friable sandstone in the geologic mapping) (Table J-2). All analyzed sedimentary rocks appeared to have strong similarities indicating a common source area for the clastic materials.

The x-ray diffraction analysis of the rock samples is presented in Table J-3, and generally showed the same mineralogy and approximately the same percentage of different minerals as the thin section analysis, but provide more detailed information on mineralogy. Dolomite dominates the carbonate fraction of the rocks and ranges from 10

to 80 percent. The clays in the rocks are kaolin (0 to 10 percent) and smectite (1 to about 60 percent), quartz is relatively constant (generally 15 to 25 percent), and is more plentiful than plagioclase (2 to 7 percent) and k-feldspar (3 to 15 percent) (total feldspar generally 5 to 15 percent). The sample of claystone (P-19) was dominated by fine grained dolomite, smectite, and quartz.

The hand samples of diabase are identified petrographically as altered gabbro/diorite, altered trachyte/ rhyolite and altered gabbro/diorite cataclasite (Table J-1). Altered grains of trachyte/rhyolite volcanic rocks are identified to be the most probable source of clay identified in the sedimentary rocks.

One sample of altered sandstone shows both alteration of plagioclase to dolomite, and weak alteration of volcanic rock fragments to clay. One sample of altered gabbro/diorite cataclastite (diabase) shows alteration of olivine (?) and plagioclase to brown clay. A sample of gabbro/diorite (diabase) exhibits hydrothermal alteration of parent minerals to clay.

4.0 REFERENCES

Diablo Canyon ISFSI Data Report A, Geologic Mapping in the Plant Site and ISFSI Site, prepared by William Lettis & Associates, Inc., November 5, 2001.

Diablo Canyon ISFSI Data Report B, Borings in ISFSI Site Area, prepared by William Lettis & Associates, Inc., November 5, 2001.

William Lettis & Associates Work Plan, Additional Geologic Mapping, Exploratory Drilling, and Completion of Kinematic Analyses for the Diablo Canyon Power Plant, Independent Spent Fuel Storage Installation Site, Rev. 2, November 28, 2000.

William Lettis & Associates Work Plan, Additional Exploratory Drilling and Geologic Mapping for the DCPP ISFSI Site, Rev. 1, September 19, 2001.

Table J-1

Petrographic Analysis of Rock Samples taken from Outcrops

Sample Number[1]	Field Identification	Map Unit[2]	Petrographic Analysis						
			Current Rock Type[3]	Parent (protolith) Rock Type	Carbonate (%) and type	Other Minerals (%)	Detrital (%)	Matrix + Cement (%)	Other Comments
98BA7-RS-2	Calcareous quartzose SANDSTONE	Tof_{b-1}	Clayey DOLOMITE [Dolomite]	Clayey limestone	78% dolo	clay (15%); qtz (5%)	13%	87%	10% microfossils; 3% qtz silt
98BA10-RS-4	Quartzose SANDSTONE	Tof_a	Clayey DOLOMITE [Dolomite]	Clayey limestone	68% dolo	clay (25%); qtz (4%)	4%	96%	1% microfossils; 3% qtz silt
98BA12-RS-6	Quartzose SANDSTONE	Tof_{b-1}	Clayey fossiliferous LIMESTONE [Limestone]	Clayey fossiliferous limestone	40% calcite	clay (40%); carb mat (8%); qtz (5%)	45%	55%	40% microfossils; 5% qtz silt
98BA16-RS-8	Siliceous arkose SANDSTONE	Tof_{b-2a}	Altered SANDSTONE [Friable Sandstone]	Volcanic sandstone	45% dolo	k-spar (15%); clay (12%); plag (11%)	45%	55%	plagioclase weakly altered to dolomite; 1% dolomitic microfossils
98BA24-RS-11	Calcareous quartzose SANDSTONE	Tof_{b-1}	Clayey DOLOMITE [Dolomite]	Clayey limestone	50% dolo	clay (42%); qtz (5%)	5%	95%	calcite completely altered to dolo; 5% qtz silt; <1% dolomitic microfossils
98C-2-RS-2	GABBRO	Tvr	Altered gabbro/diorite CATACLASITE [Diabase]	Gabbro/diorite	—	clay (71%); plag (20%); cpx (5%)	—	—	porphyroclasts are rounded to subrounded; matrix suggests cataclastic brecciation
98C-8-RS-4	Feldspathic quartzose SANDSTONE	Tof_b	Clayey DOLOMITE [Dolomite]	Clayey limestone	78% dolo	clay (15%); qtz (4%)	5%	95%	1% dolomitic microfossils; 4% qtz silt; calcite completely altered to dolo
98WT9-RS-6	GABBRO	Tvr	Altered GABBRO/ DIORITE [Diabase]	Gabbro/diorite	—	plag (70%); clay (15%); cpx (10%)	—	—	phaneritic, holocrystalline, fine grained, non-directed fabric
98WT9-RS-7	DIORITE	Tof_a	Altered GABBRO/ DIORITE [Diabase]	Gabbro/diorite	—	plag (50%); clay (38%); cpx (8%)	—	—	phaneritic, holocrystalline, fine grained, non-directed fabric; veins of clay and dolo

Table J-1

Petrographic Analysis of Rock Samples taken from Outcrops (continued)

Sample Number[1]	Field Identification	Map Unit[2]	Petrographic Analysis						
			Current Rock Type[3]	Parent (protolith) Rock Type	Carbonate (%) and type	Other Minerals (%)	Detrital (%)	Matrix + Cement (%)	Other Comments
98WT10-RS-9	Quartzose SANDSTONE	Tof_b	Clayey fossiliferous DOLOMITE	Clayey fossiliferous limestone	83% dolo	clay (15%)	60%	40%	60% dolomitic microfossils <1% qtz silt
98WT17-RS-11	Quartzose tuffaceous SANDSTONE	Tof_a	(altered) SANDSTONE [Friable Sandstone]	Volcanic sandstone	49% calcite; 12% dolo	k-spar (25%); qtz (8%); plag (5%)	88%	12%	50% calcite fossils; weak bedding; angular fragments of trachyte/rhyolite
RS-12	Zeolitized TUFF	Tor	Altered TRACHYTE/ RHYOLITE [Diabase]	Porphyritic trachyite/rhyolite	3% dolo	k-spar (44%); clay (25%); qtz (20%); plag (1%); leucoxene (5%)	—	—	2% phenocrysts (qtz 1%; plag 1%); relict flow (?) structure defines a weakly directed fabric; dolomite veins
797-56	Silty SANDSTONE	Tof_b	Clayey DOLOMITE [Dolomite]	Clayey limestone	90% dolo	clay (9%)	10%	90%	10% dolomitic microfossils <1% qtz silt; calcite completely altered to dolo

Note: Rock and mineral abbreviations are as follows: carb mat, carbonaceous matter; cpx, clinopyroxene; dolo, dolomite; kaol, kaolinite; k-spar, potassium feldspar; plag, plagioclase feldspar; qtz, quartz.

Footnotes:
1. Samples analyzed by Spectrum Petrographics, Inc., in 1998 (Attachment 1)
2. Sample locations are shown on Figure 1
3. See unit descriptions in Data Report A.
4. Rock type shown is the current lithology of the rock as given by Spectrum Petrographics, Inc. Rock type shown in brackets is the rock name used in this report.

Table J-2

Petrographic Analysis of Rock Samples from Borings in ISFSI Site Area

Sample Number	Borehole No.	Sample Depth (Feet)	Field Identification	Map Unit[1]	Petrographic Analysis						
					Current Rock Type[2]	Parent (Protolith) Rock Type	Carbonate (%) and type	Other Minerals (%)	Detrital (%)	Matrix + Cement (%)	Other Comments
P-1	01-I	4.0	Tan DOLOMITE	Tof_{b-1}	Altered Clayey CARBONATE [Dolomite]	Clayey fossiliferous limestone	70% dolo	clay (15%); calcite (10%); qtz (5%)	15%	85%	alteration of sparse clay veins; 10% calcitic microfossils
P-2	00BA-1	11.5	Tan DOLOMITE	Tof_{b-1}	Altered Clayey CARBONATE [Dolomite]	Clayey fossiliferous limestone	68% dolo	clay (20%); calcite (5%); qtz (5%)	11%	89%	opaques moderately altered to FeOH; 5% calcitic microfossils
P-3	00BA-1	146	Gray SANDSTONE	Tof_{b-1}	Altered Clayey CARBONATE [Dolomite]	Clayey limestone	50% dolo	clay (22%); kaol (15%); qtz (10%)	10%	90%	no alteration observed 9% sponge spicules
P-4	01-F	120	Gray SANDSTONE	Tof_{b-2a}	Altered SANDSTONE [Friable Sandstone]	Arkose volcaniclastic limestone	20 % dolo	k-spar (25%); kaol (20%); clay (18%); qtz (15%)	50%	15%	veinlets of dolomite; k-spar moderately altered to clay; volcanic glass (?) moderately altered to dolo+kaol+qtz, sponge spicules (7%)
P-5	98BA-2	56.5	Gray and yellow SANDSTONE	Tof_{b-2a}	Altered SANDSTONE [Friable Sandstone]	Feldspathic litharenite volcaniclastic sandstone	45% dolo	clay (30%); kaol (10%); qtz (10%), k-spar (5%)	35%	65%	k-spar moderately altered to clay, trachyte (?) lithic fragments strongly altered to clay; opaques moderately altered to FeOH
P-6	01-B	6.7	Brown SANDSTONE	Tof_{b-2}	Altered SANDSTONE [Sandstone]	Lithic arkose volcaniclastic sandstone	21% dolo	k-spar (30%); clay (21%), kaol (15%), qtz (10%)	40%	60%	volcanic glass (?) completely altered to kaol+dolo+k-spar, opaques completely altered to FeOH; k-spar strongly altered to porosity+dolo
P-7	98BA-1	2.5	Friable (Altered) DOLOMITE	Tof_{b-1a}	Altered Clayey CARBONATE [Friable Dolomite]	Clayey limestone	40% dolo	kaol (37%); qtz (10%); clay (10%)	11%	89%	sponge spicules (5%); no alteration observed
P-8	00BA-2	23.5	Friable (Altered) DOLOMITE	Tof_{b-1a}	Altered SILTSTONE [Friable Dolomite]	Mixed bioclastic and volcaniclastic siltstone	none present	kaol (38%); clay (20%); k-spar (20%); qtz (15%)	38%	62%	sponge spicues (7%); volcanic glass (?) completely altered to kaol+clay; opaques strongly altered to FeOH; k-spar strongly altered to porosity+dolo
P-9	01-E	6.5	Friable (Altered) DOLOMITE	Tof_{b-1a}	Altered Calcareous brecciated CLAYSTONE [Friable Dolomite]	Calcareous claystone breccia	40% dolo	clay (40%); qtz (10%); FeOH (3%); calcite (2%); apatite (1%); plag (<1%)	-	-	cataclastically brecciated, calcite+dolo veins; k-spar altered to porosity+dolo; opaques altered to FeOH

Table J-2

Petrographic Analysis of Rock Samples from Borings in ISFSI Site Area (continued)

Sample Number	Borehole No.	Sample Depth (Feet)	Field Identification	Map Unit[1]	Petrographic Analysis						
					Current Rock Type[2]	Parent (Protolith) Rock Type	Carbonate (%) and type	Other Minerals (%)	Detrital (%)	Matrix + Cement (%)	Other Comments
P-10	01-E	78.8	Gray SANDSTONE	Tof_{b-2a}	Altered SANDSTONE [Friable Sandstone]	Lithic arkose volcaniclastic sandstone	20% dolo	k-spar (35%); clay (19%); qtz (15%); kaol (5%)	50%	50%	k-spar strongly altered to porosity+kaol+dolomite; veinlets of calcite
P-11	01-D	8	Tan DOLOMITE	Tof_{b-1}	Altered Clayey CARBONATE [Dolomite]	Clayey limestone	55% dolo	clay (15%); kaol (13%); qtz (10%)	13%	87%	carbonate fossil fragments (<1%); opaques strongly altered to FeOH; original calcite (?) fossil fragments strongly altered to dolomite
P-12	01-G	26.5	Tan DOLOMITE	Tof_{b-1}	Altered Bioclastic LIMESTONE [Dolomite]	Bioclastic limestone	55% calcite; 15% dolo	brown clay (10%); qtz (10%); kaol (6%); K-spar (10%)	65%	35%	calcite fossil fragments (50%); opaques completely altered to FeOH, calcite fossil fragments weakly altered to dolomite; a single vein of FeOH
P-13	00BA-1	6	Tan DOLOMITE	Tof_{b-1}	Altered Bioclastic LIMESTONE [Dolomite]	Bioclastic limestone	50% calcite; 15% dolo	brown clay (15%); qtz (10%); kaol (5%)	62%	38%	calcite fossil fragments (50%); opaques completely altered to FeOH; calcite fossil fragments weakly altered to dolomite
P-14	01CTF-A	18	Yellow SANDSTONE	Tof_{b-2a}	Altered Sandy CARBONATE [Friable Sandstone]	Sandy limestone	61% dolo	brown clay (13%); qtz (10%); kaol (8%); k-spar (7%)	37%	63%	sponge spicules (9%); opaques completely altered to FeOH; glass shards or fish bones completely altered to kaol+brown clay
P-15	01-I	205.5	Gray DOLOMITE/ fine-grained SANDSTONE	Tof_{b-1}	Altered Sandy CARBONATE [Dolomite]	Sandy limestone	45% dolo; 5% calcite	brown clay (20%); kaol (15%), qtz (10%)	32%	68%	altered foram fragments (20%); calcite fossil fragments strongly altered to dolo+kaol; k-spar moderately altered to dolo+qtz
P-16	01-I	308	Gray-brown laminated dolomitic SANDSTONE	Tof_{b-1}	Altered Calcareous CLAYSTONE [Dolomite]	Calcareous claystone	37% dolo	clay (45%); qtz (10%); k-spar (5%)	15%	85%	sponge spicules (5%); no alteration observed
P-17	-	-	(skip in numbering, no sample collected)	-	-	-	-	-	-	-	-
P-18	01-I	124	Clayey Sandstone	Tof_{b-1a}	Altered SANDSTONE [Friable Sandstone]	Medium feldspathic litharenite volcaniclastic sandstone	25% dolo, 5% calcite	k-spar (25%); kaol (15%); qtz (15%); brown clay (10%)	61%	39%	veins or mineralized cataclastic structures of dolomite; K-spar moderately altered to dolomite+kaol; opaques strongly altered to FeOH
P-19	01-I	106	Clay bed	Tof_{b-1}	Altered Calcareous CLAYSTONE [Claystone]	Calcareous claystone	42% dolo	clay (45%); k-spar (5%)	8%	92%	cataclastic deformation, opaques completely altered to FeOH

Table J-2

Petrographic Analysis of Rock Samples from Borings in ISFSI Site Area (continued)

Sample Number	Borehole No.	Sample Depth (Feet)	Field Identification	Map Unit[1]	Petrographic Analysis						
					Current Rock Type[2]	Parent (Protolith) Rock Type	Carbonate (%) and type	Other Minerals (%)	Detrital (%)	Matrix + Cement (%)	Other Comments
P-20	01CTF-A	58	Medium-grained SANDSTONE	Tof_{b-2a}	Altered SANDSTONE [Friable Sandstone]	Medium feldspathic litharenite volcaniclastic sandstone	20% dolo	clay (61%); qtz (7%); k-spar (6%)	16%	84%	volcanic glass (?) completely altered to clay+dolomite
P-21	01CTF-A	18.5	Fine-grained DOLOMITE	Tof_{b-2a}	Altered Clayey CARBONATE [Friable Sandstone]	Clayey fossiliferous limestone	71% dolo	clay (15%); qtz (10%)	14%	86%	no alteration features observed
P-22	01-H	7	Very fine-grained dolomitic SANDSTONE	Tof_{b-1}	Altered Calcareous CLAYSTONE [Claystone]	Calcareous claystone w/ significant volcaniclastics	39% dolo	clay (39%); qtz (10%); k-spar (8%)	18%	82%	k-spar weakly altered to dolomite+kaol; opaques completely altered to FeOH
P-23	01-I	5	DOLOMITE	Tof_{b-1}	Altered Clayey CARBONATE [Dolomite]	Clayey fossiliferous limestone	65% dolo; 10% calcite	clay (15%); qtz (5%)	16%	84%	10% calcitic microfossils; Calcite strongly altered to dolomite; opaques strongly altered to FeOH

Note: Rock and mineral abbreviations are as follows cpx, clinopyroxene, dolo, dolomite; kaol, kaolinite, k-spar, potassium feldspar, plag, plagioclase feldspar, qtz, quartz, FeOH, all iron hydroxide compounds

Footnotes:
1. Samples analyzed by Spectrum Petrographics, Inc , in 2001 (Attachment 2)
2. See unit descriptions in Data Report A
3. Rock type shown is the current lithology of the rock as given by Spectrum Petrographics, Inc Rock type shown in brackets is the rock name used in this report

Table J-3
X-Ray Diffraction Analysis of Rock Samples from Borings in ISFSI Site Area

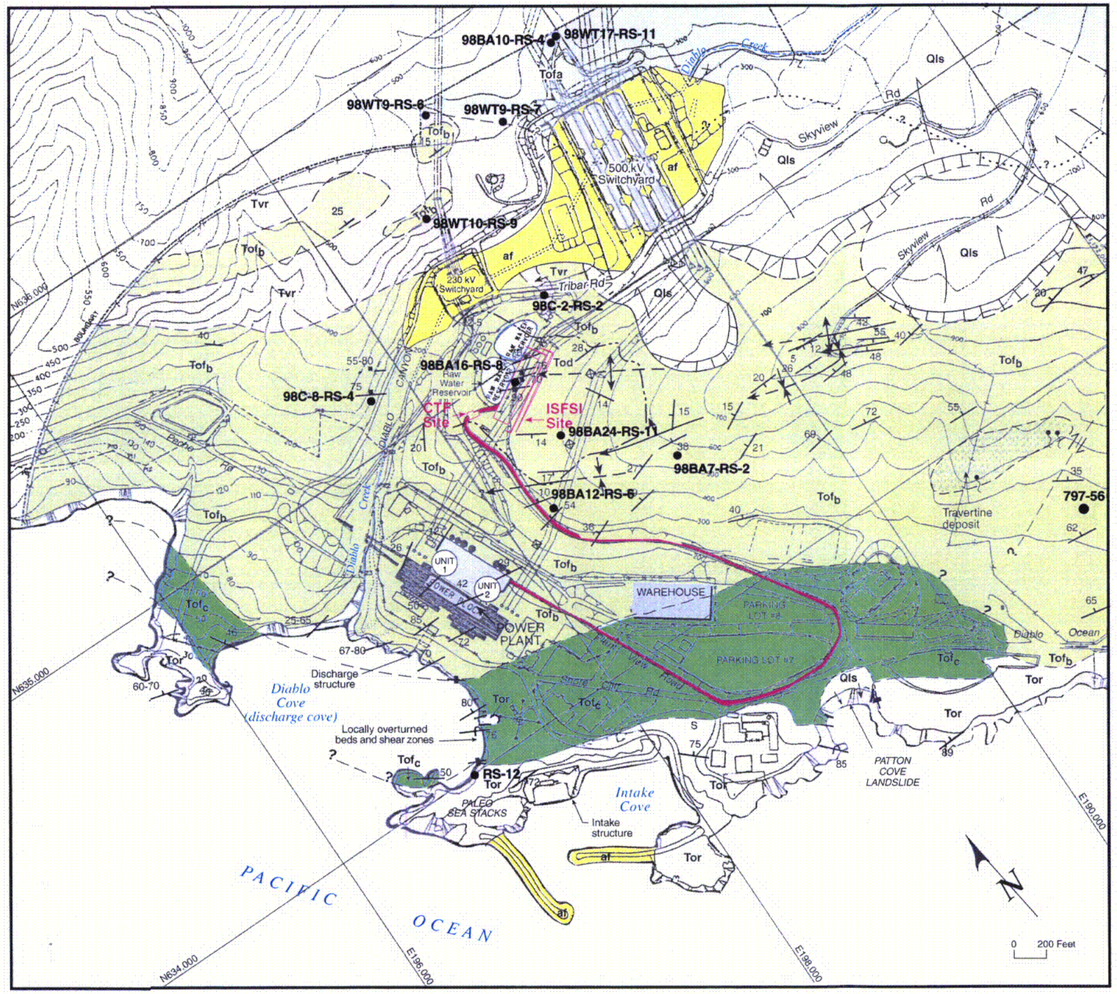
Sample Number	Borehole No. and sample depth (ft)	Current Rock Type and map unit[2]	Parent (Protolith) Rock Type	Quartz	Plagioclase	K-feldspar	Calcite	Dolomite	Ferroan Dolomite	Carbonate Apatite	Pyrite	Goethite	Kaolin	Smectite	Mixedlayer illite-smecti	Amorphous[3]	Comments
P-6 (bulk)	01-B 6.7	Altered SANDSTONE [sandstone] Tof_{b-2}	Lithic arkose volcaniclastic sandstone	24	4	15		11			1?	tr	10	30		5	
P-9 (bulk)	01-E 6.5	Calcareous brecciated CLAYSTONE [friable dolomite] Tof_{b-1a}	Calcareous claystone breccia	20	2	7	10	17		^3?		tr	3	13		^25	^ poorly crystalline carbonates + apatite?
P-10 (bulk)	01-E 78.8	Altered SANDSTONE [sandstone] Tof_{b-2a}	Lithic arkose volcaniclastic sandstone	21	4	9	1	15			3		6	27		14	
P-11 (bulk)	01-D 8.0	Altered Clayey CARBONATE [dolomite] Tof_{b-1}	Clayey limestone	31	1	7		42				tr	3	1		15	
P-18 (bulk) (clay separated)	01-I 124.0	Altered SANDSTONE [friable sandstone] Tof_{b-1a}	Medium feldspathic litharenite volcaniclastic sandstone	16	3	9	4	15				2	9 *75	42 24	1	-	* very fine grained
P-19 (bulk) (clay separated)	01-I 106.0	Altered Calcareous CLAYSTONE [claystone] Tof_{b-1}	Calcareous claystone	20	2	3		35				4	4 16	32 84		-	dioctahedral smectite

Table J-3
X-Ray Diffraction Analysis of Rock Samples from Borings in ISFSI Site Area

Sample Number	Borehole No. and sample depth (ft)	Current Rock Type and map unit[2]	Parent (Protolith) Rock Type	Quartz	Plagioclase	K-feldspar	Calcite	Dolomite	Ferroan Dolomite	Carbonate Apatite	Pyrite	Goethite	Kaolin	Smectite	Mixedlayer illite-smecti	Amorphous[3]	Comments			
P20	O1CTF-A	Altered Sandstone (friable sandstone Tof_{b-1})	Medium feldspathic litharenite volcaniclastic sandstone	14	6	4		15				4	15	57						
P-21 (bulk)	01CTF-A 18.5	Altered Clayey CARBONATE [friable sandstone] Tof_{b-1}	Clayey fossiliferous limestone	7				78					1	14		-				
P-22 (bulk)	01-H 7.0	Altered Calcareous CLAYSTONE [claystone] Tof_{b-1}	Calcareous claystone w/ significant volcaniclastics	20	2	6		33				3	5	31		-				
P-23 (bulk)	01-I 5.0	Altered Clayey CARBONATE [dolomite] Tof_{b-1}	Clayey fossiliferous limestone	16	2	5	20	8	19			tr	tr	2		^ 28				

Note: Samples analyzed by Spectrum Petrographics, Inc. in 2001 (Attachment 2). tr = trace, ? = tentative identification, - = below detection

Footnotes:
1. Rock type shown is the current lithology of the rock as given by Spectrum Petrographics, Inc. Rock type shown in brackets is the rock name used in this report.
2. See unit descriptions in Data Report A.
3. Amorphous content may consist of iron oxides, hydroxides, opaline silica, and/or carbonates or clays that are not as crystaline as the standard used for quantification.



Explanation

af — Artificial fill (engineered)

Qls — Quaternary landslide deposits

Tvr — Volcanic rock (middle Miocene), diabase intrusions of gabbro and diorite composition

Obispo Formation

(lower and middle Miocene) - bedded dolomitic sandstone, siltstone, and claystone with tuffaceous beds, locally calcareous, some chert and volcanic rock lenses

Member Tof - Sandstone and Dolomite

Tertiary

Tof_a — Unit a - Siltstone and sandy siltstone; yellow-brown to tan; thick to massive bedding; locally calcareous and diatomaceous; low to moderate hardness; low to moderate density; very blocky to blocky

Tof_b — Unit b - Dolomitic sandstone and dolomite; gray, yellow-brown, brown, and bluish gray; medium to very thick bedding, some units massive; moderately hard to hard; medium density; calcite and quartz veins; very blocky to blocky.

Tof_c — Unit c - Siliceous claystone and siltstone with lesser sandstone.

Tor — Member Tor - volcanic rock, zeolitized and silicified tuff.

Fault, dashed where approximate, queried where uncertain, arrows show sense of movement

Geologic contact, solid line where well-defined, dashed where approximate, queried and/or dotted where uncertain

Cut or fill slope

Large landslides. Arrows indicate direction of movement, hachures define head scarp. (Smaller landslides are not shown)

500 kV tower

10 — Generalized strike and dip of bedding

Parasitic folds on south limb of Pismo syncline

Axis of anticline, plunge indicated by solid arrow, dashed where approximately located

Axis of syncline, plunge indicated by solid arrow, dashed where approximately located

Axis of monocline, plunge indicated by solid arrow, dashed where approximately located

Bedrock fault or shear zone, dashed where approximately located or buried, queried where uncertain.

Outline of 1971 borrow excavation (ISFSI site area)

Steep sea cliff

65 — Strike and dip of fault

Spring

Note: Except small faults at and near the ISFSI site, only major geologic structures and bedrock units, and large landslides, are shown.

Data sources

Base Map: PG&E Civil Site Facilities Layout Plan (modified 1994)
Compilation from air photos, PG&E Flight 753A, 1987 (scale 1:7,200)

Geology modified from Hall (1973) and Hall and others (1979)

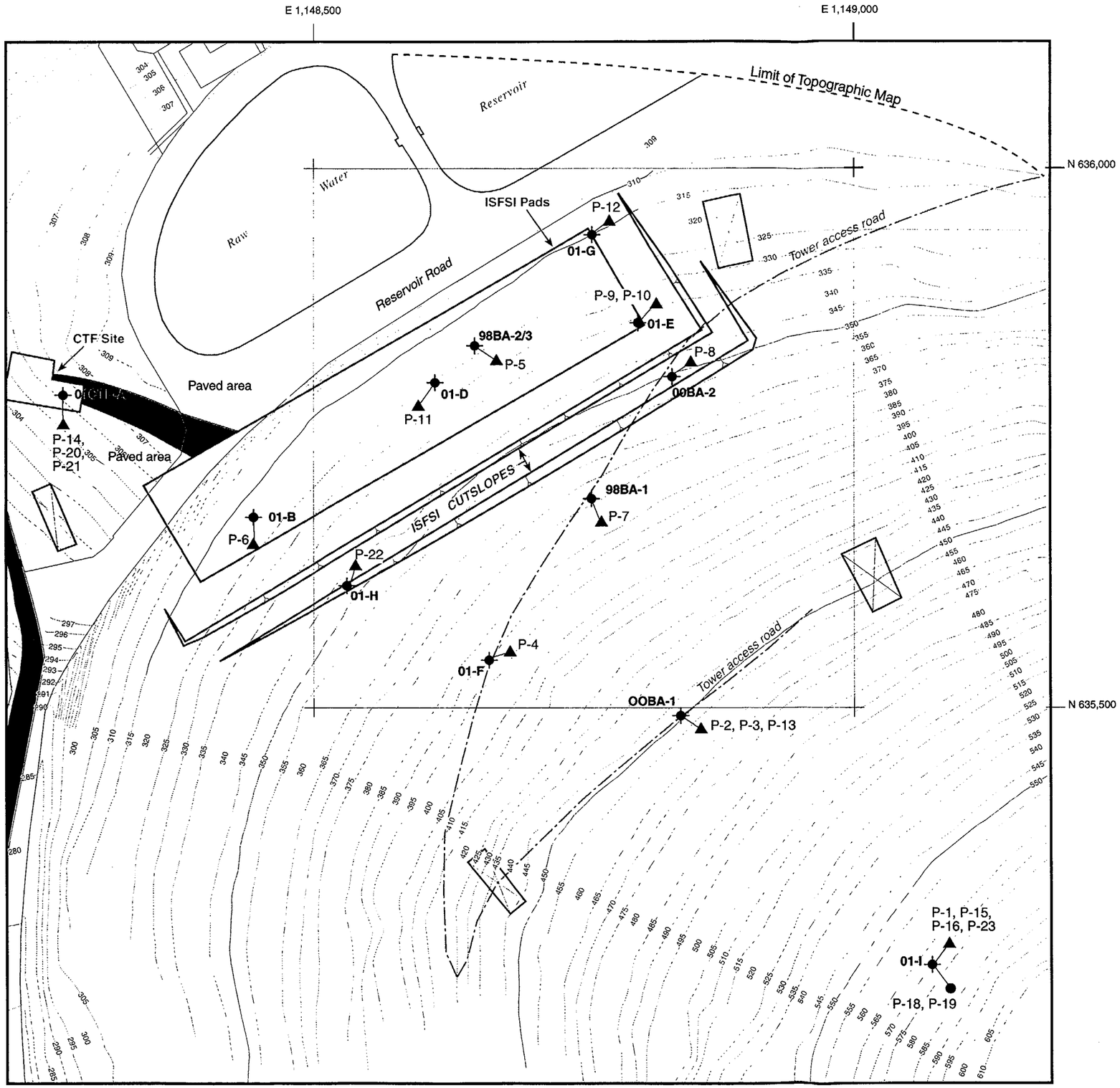
Topography from PG&E, 1986 (and later revisions) Plot plan drawing 471124

SAFETY ANALYSIS REPORT

DIABLO CANYON ISFSI

FIGURE J-1
1998 PETROGRAPHIC SAMPLE LOCATIONS FROM SURFACE EXPOSURES

C01



EXPLANATION

- Footprint of 500 kV tower
- Outline of ISFSI Pads
- O1-C — Boring for ISFSI, number indicated (initial number is year drilled)
- Proposed cut slope above ISFSI Pads
- P-1 ▲ — Rock petrographic sample location, showing Spectrum Laboratories sample number
- P-18 ● — Clay bed petrographic sample location, showing Spectrum Laboratories sample number

N

0 50 100 150 200

Contour interval = 5 feet

SAFETY ANALYSIS REPORT

DIABLO CANYON ISFSI

FIGURE J-2
2001 PETROGRAPHIC SAMPLE LOCATIONS FROM BOREHOLES

DATA REPORT J

ATTACHMENT 1

SPECTRUM PETROGRAPHICS, INC., REPORT ENTITLED "DIABLO CANYON DCSF PETROGRAPHIC REPORT #HSI",

DATED OCTOBER 13, 1998.

DIABLO CANYON ISFSI

Diablo Canyon DCSF

Petrographic Report #HSI

October 13, 1998

for

Mr. Patrick E. Drouin
William Lettis & Associates, Inc.
1777 Botelho Drive, Suite 262
Walnut Creek, CA 94596

by

Michael DePangher, Ph.D.
Spectrum Petrographics, Inc.

Comments

All the sedimentary rocks in this group have strong similarities and appear to be derived from a common source area with distinctive trachyte/rhyolite volcanic material. This volcanic material is probably the source of most clay in the sedimentary rocks.

Sample 98C-2-RS-2 (gabbro cataclasite) was probably derived from the protolith represented by samples 98WT9-RS6 and 98WT9-RS7.

Key to Petrographic and Photomicrographic Descriptions

Clay minerals common in altered rocks must often be identified by X-ray diffraction either because their optic properties are not diagnostic or because they are too fine grained to be reliably identified by optical methods. The term "clay" is used herein to denote fine grained phyllosilicates in general. Under ideal conditions, it is often possible to optically discriminate between 4 major groups: kaolinite, smectite, mica (including illite), and chlorite. This is done whenever conditions permit.

The term "sericite" is applied to fine grained colorless phyllosilicates that show upper 2nd order maximum interference colors. These could include muscovite, illite, paragonite, lepidolite, margarite, clintonite, pyrophyllite, and talc. The term "intermediate clay" is applied to fine grained very pale or colorless phyllosilicates that show upper 1st order maximum interference colors. These are probably dominated by chlorite, smectite, and mixed-layer illite/smectite.

The term "opaques" is used to refer to all materials opaque (and sometimes semi-opaque) to transmitted light. The term "FEOH" is herein used to indicate fine grained, yellowish to reddish brown, earthy materials of varying opacity in transmitted light. FEOH is probably mostly Fe oxy-hydroxides but may sometimes include sphalerite, realgar, orpiment, jarosite, a number of Mn oxy-hydroxides, and organic matter.

Particle size distributions are given as (A-B-C μm), where A, B, and C are the smallest, median, and largest particle sizes, respectively, in microns. A question mark (?) in the position of A, B, or C indicates that the value of A, B, or C was indeterminate, probably because of excessively large or small particle size or statistically insignificant numbers of particles.

Mineral abundances are visual estimates. For multi-lithologic materials (cuttings, etc...), mineralogy, textures, and alteration are described only for the dominant lithology.

Section preparation codes are as follows: (1) Format: 27 x 46 mm, 51 x 76 mm, or 1" round; (2) Finish: standard lapping (STD) or polished (POL); (3) Stains: sodium cobaltinitrite (SCN), alizarin red S (ARS), potassium ferricyanide (PF), and barium chloride + potassium rhodizonate (BCPR); and (4) Cover: none, permanent Loctite acrylic (PLA), or removable Canada Balsam (RCB).

Photomicrograph captions/labels contain the following items of information in consecutive order separated by forward slashes: (1) sample identification, (2) film roll number, (3) frame number, (4) type of illumination, (5) field of view (FOV) <u>or</u> the magnification on the color print, which is given as the number of times actual size (ie., 32X), and (6) the job identification number. "PPL" indicates plane-polarized light; "XPL indicates cross-polarized light. "R" indicates reflected light. "550" means that a 550 nanometer wavelength plate was inserted to highlight features of extremely low birefringence. "C" indicates that the substage condenser was <u>in</u> (sometimes used for Fe-oxides). "O" indicates substage condenser in an oblique position. These various illuminations can be combined. "CON" indicates conoscopic illumination. For normal photography of hand specimens, the focal length of the lens used is given rather than the magnification. POL means that a polarizing filter was used with the lens, and DAY means the sample was photographed in diffused daylight.

Features on photomicrographs can be located by overlaying the accompanying orthogonal plastic grid. A block of squares is marked by referencing the uppermost left and lowermost right corners of the block, ie. A6-E15. Linear features are marked by designating the extent of the feature from beginning to ending points, ie. B6 to L19.

A question mark after a rock or mineral name in a petrographic description means that there is some degree of uncertainty about the identification of that rock or mineral.

The size of an alteration selvege around a vein is given as a half-width (the width of a selvege on one side of the vein) expressed as a fraction of the associated vein width (vw).

SAMPLE # 98BA7-R~~A~~S-2 STP per SCL October 13, 1998

ROCK NAME CLAYEY DOLOMITE -- probably formed by alteration (secondary dolomite + quartz + FEOH) of a sparsely fossiliferrous clayey limestone protolith.

MINERALS Dolomite (78%) + clay (mostly kaolinite) (15%) + quartz (5%) + FEOH (2%).

TEXTURES Mixed chemical and clastic sedimentary. Weakly developed bedding defines a weakly directed fabric.

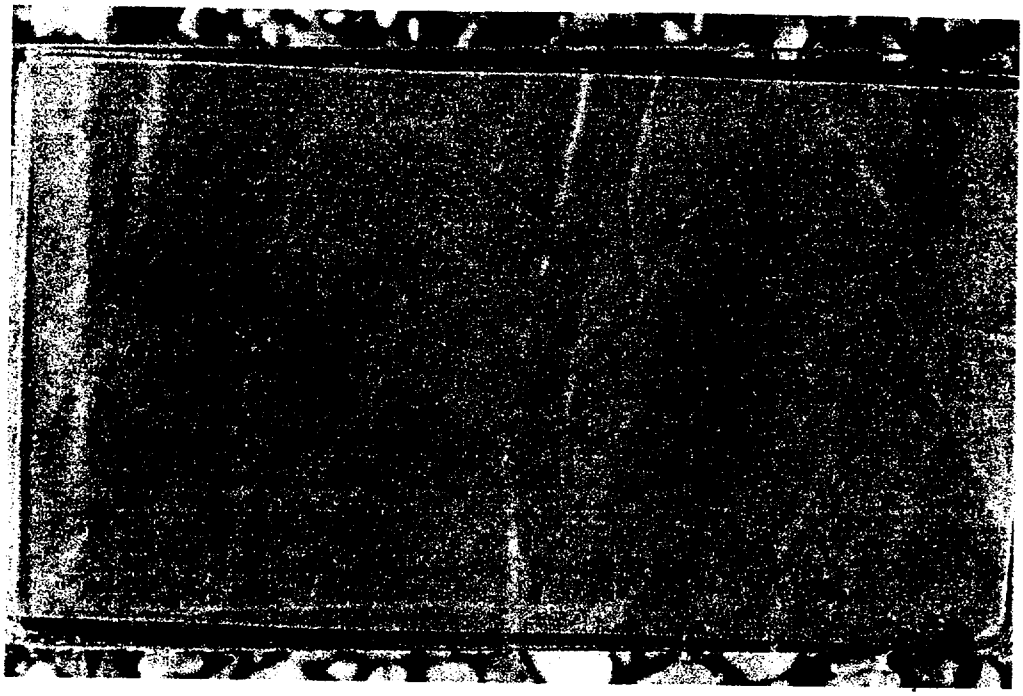
Detrital Framework Components (13%) are 20-120-600 μm dolomitic microfossils (10%) + angular quartz silt (3%). Contacts between detrital framework components grains are floating.

Matrix/Cement (87%) is composed of fine sparry dolomite + FEOH-stained clay.

ALTERATION The following alteration features are present but of indeterminate relative ages: (1) veins of dolomite; (2) calcite completely altered to dolomite; and (3) dolomite weakly altered to quartz.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS 98BA7-RA-2/98025/01/DAY/3X/HSI CLAYEY DOLOMITE showing typical appearance of hand specimen.



98BA7-RA-2
5
JTF per SCL

SAMPLE # 98C-2-RS-2 October 13, 1998

ROCK NAME ALTERED GABBRO/DIORITE CATACLASITE -- probably formed by cataclasis and alteration (secondary brown clay + FEOH) of a fine grained gabbro/diorite intrusive protolith.

MINERALS Brown clay (probably FEOH-stained chlorite + smectite) + plagioclase (20%) + clinopyroxene (5%) + FEOH (2%) + opaques (2%).

TEXTURES Cataclastic; weakly directed fabric. Cataclasis has produced a continuous size variation between clasts and matrix.

Porphyroclasts (?%) are subround to round, ?-1000-4000 μm lithic fragments of altered gabbro/diorite. Contacts between porphyroclasts are floating.

Matrix (?%) is composed of the altered comminuted equivalent of the clasts, suggesting a dominantly cataclastic mechanism of brecciation.

ALTERATION The following alteration features are also present but of indeterminate relative ages: (1) cataclastic brecciation; (2) olivine (?) completely altered to brown clay; (3) plagioclase moderately altered to brown clay; and (4) clinopyroxene moderately altered to brown clay.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS 98C-2-RS-2/98025/06/DAY/3X/HSI ALTERED GABBRO/DIORITE CATACLASITE showing typical appearance of hand specimen.

98C-2-RS-2/98025/20/XPL/28X/HSI ALTERED GABBRO/DIORITE CATACLASITE showing typical appearance of fragments of gabbro/diorite in an altered matrix now dominated by clay + FEOH.

98C-2-RS-2/98025/21/XPL/28X/HSI ALTERED GABBRO/DIORITE CATACLASITE showing typical appearance of fragments of gabbro/diorite in an altered matrix now dominated by clay + FEOH.

98C-2-RS-2

SAMPLE # 98C-8-RS-4 October 13, 1998

ROCK NAME CLAYEY DOLOMITE -- probably formed by alteration (secondary dolomite + quartz + FEOH) of a sparsely fossiliferrous clayey limestone protolith.

MINERALS Dolomite (78%) + clay (mostly kaolinite) (15%) + quartz (4%) + FEOH (2%) + opaques (1%).

TEXTURES Mixed chemical and clastic sedimentary. Weakly developed bedding defines a weakly directed fabric.

Detrital Framework Components (5%) are 20-60-360 μm dolomitic microfossils (1%) + angular quartz silt (4%). Contacts between detrital framework components grains are floating.

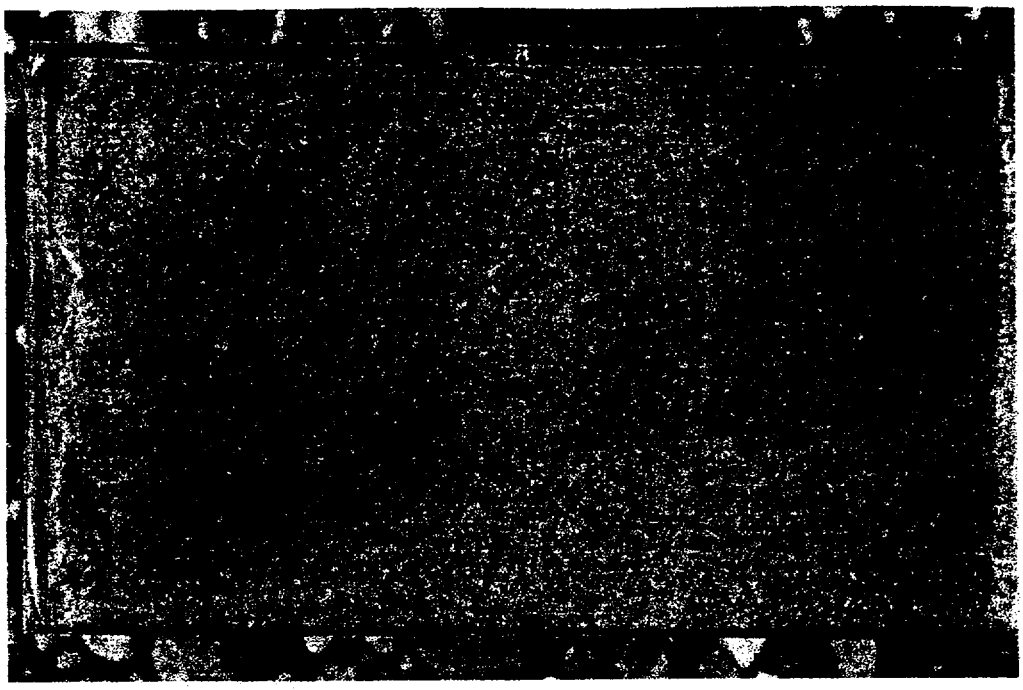
Matrix/Cement (95%) is composed of fine sparry dolomite + FEOH-stained clay.

ALTERATION The following alteration features are present but of indeterminate relative ages: (1) calcite completely altered to dolomite; and (2) dolomite weakly altered to quartz.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS 98C-8-RS-4/98025/07/DAY/3X/HSI CLAYEY DOLOMITE showing typical appearance of hand specimen.

Spectrum Petrographics, Inc. 499 Dillard Gardens Road, Suite 2 · Winston · OR · 97496 · USA Phone (800) 625-2476



98C-8-RS-4

SAMPLE # 98BA10-RS-4 October 13, 1998

ROCK NAME CLAYEY DOLOMITE -- probably formed by alteration (secondary dolomite + quartz + FEOH) of a sparsely fossiliferrous clayey limestone protolith.

MINERALS Dolomite (68%) + clay (mostly kaolinite) (25%) + quartz (4%) + FEOH (3%).

TEXTURES Mixed chemical and clastic sedimentary; non-directed fabric.

Detrital Framework Components (4%) are 50-90-360 μm dolomitic microfossils (1%) + angular quartz silt (3%). Contacts between detrital framework components grains are floating.

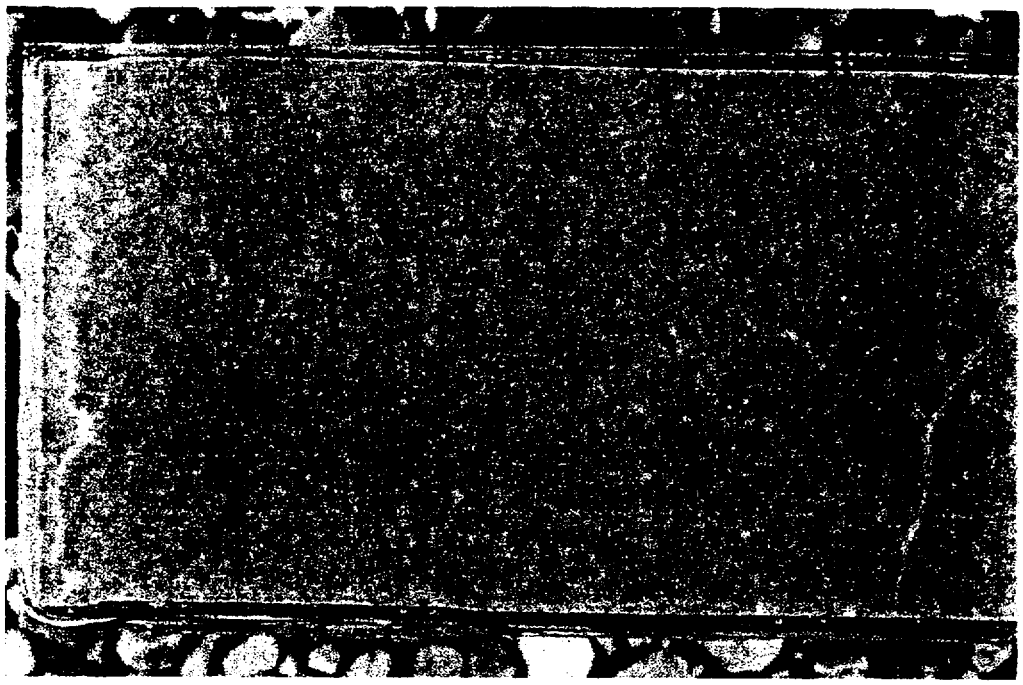
Matrix/Cement (96%) is composed of fine sparry dolomite + FEOH-stained clay.

ALTERATION The following alteration features are present but of indeterminate relative ages: (1) calcite completely altered to dolomite; and (2) dolomite weakly altered to quartz.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS 98BA10-RS-4/98025/02/DAY/3X/HSI CLAYEY DOLOMITE showing typical appearance of hand specimen.

Spectrum Petrographics, Inc. 499 Dillard Gardens Road, Suite 2 · Winston · OR · 97496 · USA Phone (800) 625-2476



98BA10-RS-4

SAMPLE # 98BA12-RS-6 October 13, 1998

ROCK NAME CLAYEY FOSSILIFERROUS LIMESTONE -- probably formed by alteration (secondary quartz + FEOH) of a clayey fossiliferrous limestone protolith.

MINERALS Calcite (40%) + clay (mostly kaolinite) (40%) + carbonaceous matter (8%) + quartz (5%) + opaques (4%) + FEOH (3%).

TEXTURES Mixed chemical and clastic sedimentary. Weakly developed bedding defines a weakly directed fabric. The "contact" seen in hand specimen is a color variation apparently imparted by differential oxidation. It crosscuts bedding but is not detectable in thin section in any illumination.

Detrital Framework Components (45%) are 40-100-320 μm calcite microfossils (40%) + angular quartz silt (5%). Contacts between detrital framework components grains are floating to tangential.

Matrix/Cement (55%) is composed of FEOH-stained clay + carbonaceous matter.

ALTERATION No other alteration features were observed.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

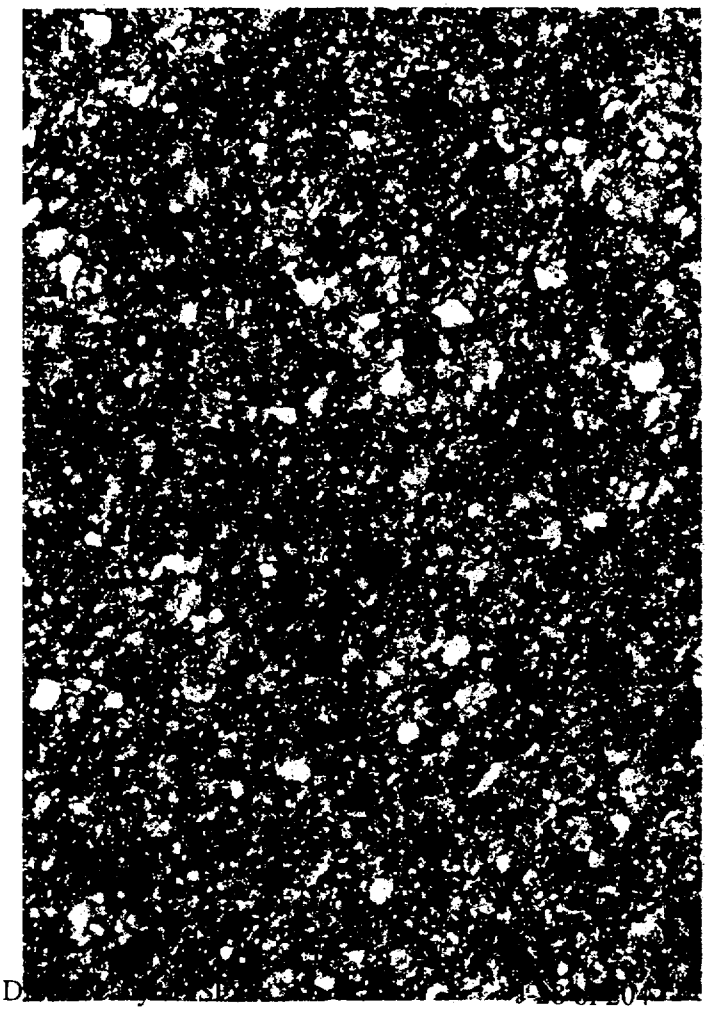
PHOTOS 98BA12-RS-6/98025/03/DAY/3X/HSI CLAYEY FOSSILIFERROUS LIMESTONE showing typical appearance of hand specimen.

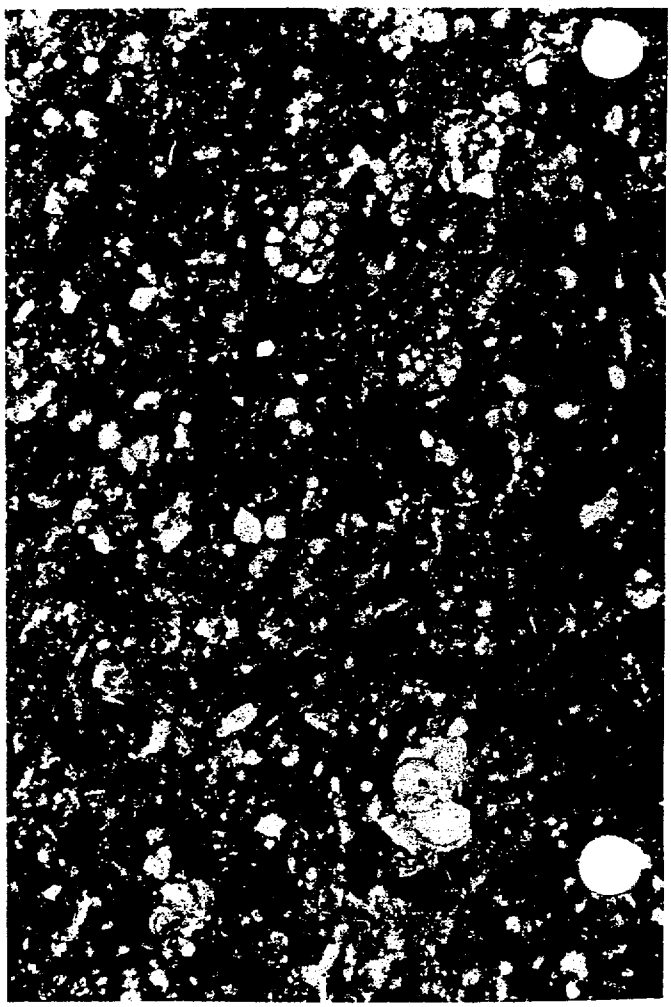
98BA12-RS-6/98025/14/XPL/57X/HSI CLAYEY FOSSILIFERROUS LIMESTONE showing typical appearance with sparse angular quartz silt grains (K4, M21).

98BA12-RS-6/98025/15/XPL/57X/HSI CLAYEY FOSSILIFERROUS LIMESTONE showing typical closeup appearance of calcitic microfossil material (M7, M19, I23).

Spectrum Petrographics, Inc. 499 Dillard Gardens Road, Suite 2 · Winston · OR · 97496 · USA Phone (800) 625-2476

98BA12-RS-6





SAMPLE # 98BA16-RS-8 October 13, 1998

ROCK NAME ALTERED SANDSTONE -- probably formed by alteration (secondary dolomite clay + FEOH) of a fine grained volcanic sandstone.

MINERALS Dolomite (45%) + K-feldspar (15%) + clay (mostly kaolinite + smectite) + quartz (12%) + plagioclase (11%) + FEOH (1%) + opaques (<1%).

TEXTURES Clastic sedimentary; non-directed fabric.

Detrital Framework Components (45%) are angular to subangular, 40-160-1000 μm, [rock fragments of trachyte/rhyolite porphyry (15%) + chert (<1%)] + monocrystalline [plagioclase (11%) + K-feldspar (5%) + quartz (2%)] + dolomitic fossil fragments (1%). Contacts between grains are floating to tangential.

Matrix/Cement (55%) is composed of sparry dolomite + FEOH-stained clay.

ALTERATION The following alteration features are present but of indeterminate relative ages: (1) plagioclase weakly altered to dolomite; and (2) rock fragments of trachyte/rhyolite weakly altered to clay.

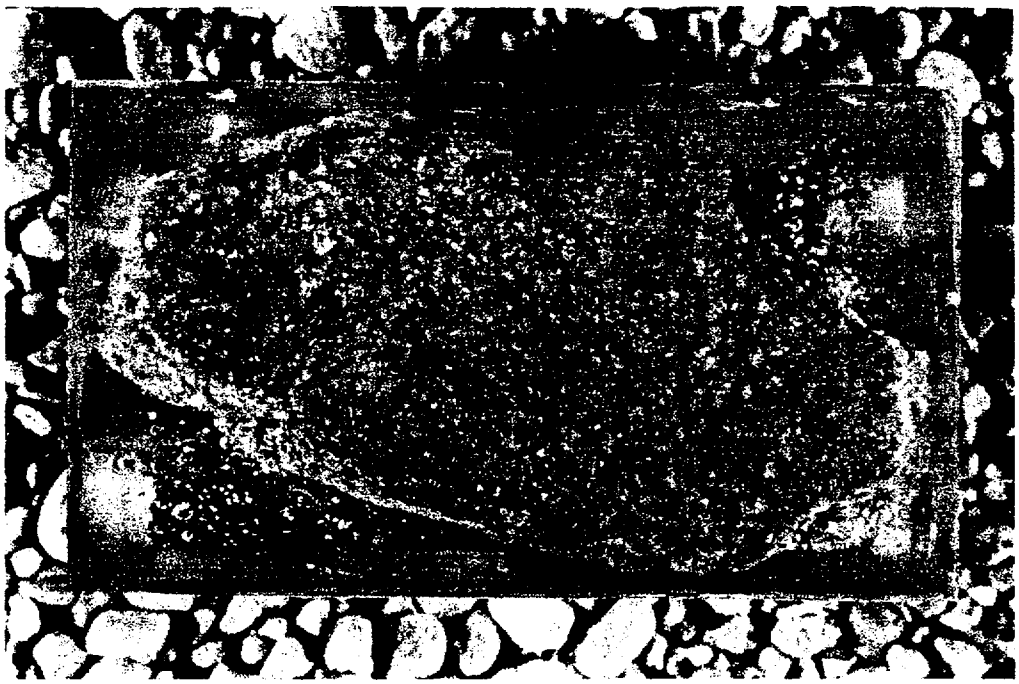
SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS 98BA16-RS-8/98025/04/DAY/3X/HSI ALTERED SANDSTONE showing typical appearance of hand specimen.

98BA16-RS-8/98025/16/XPL/28X/HSI ALTERED SANDSTONE showing typical appearance with lithic fragments of altered trachyte/rhyolite porphyry (dark; K2-M5; D5-E8; S7-T9), phenocryst fragments of quartz (R4, H27) and plagioclase (S18), and sparry dolomite (K20).

98BA16-RS-8/98025/17/PPL/57X/HSI ALTERED SANDSTONE showing typical appearance of a lithic fragment of altered trachyte/rhyolite porphyry composed of a quartz phenocryst fragment (J15) in a fine grained potassic groundmass (M12-O14); stained brownish by K-stain).

Spectrum Petrographics, Inc. 499 Dillard Gardens Road, Suite 2 · Winston · OR · 97496 · USA Phone (800) 625-2476



98BA16-RS-8

SAMPLE # 98BA24-RS-11 October 13, 1998

ROCK NAME CLAYEY DOLOMITE -- probably formed by alteration (secondary dolomite + quartz + FEOH) of a sparsely fossiliferrous clayey limestone protolith.

MINERALS Dolomite (50%) + clay (mostly kaolinite) (42%) + quartz (5%) + FEOH (3%).

TEXTURES Mixed chemical and clastic sedimentary; non-directed fabric.

Detrital Framework Components (5%) are 20-40-440 μm dolomitic microfossils (<1%) + angular quartz silt (5%). Contacts between detrital framework components grains are floating.

Matrix/Cement (95%) is composed of fine sparry dolomite + FEOH-stained clay.

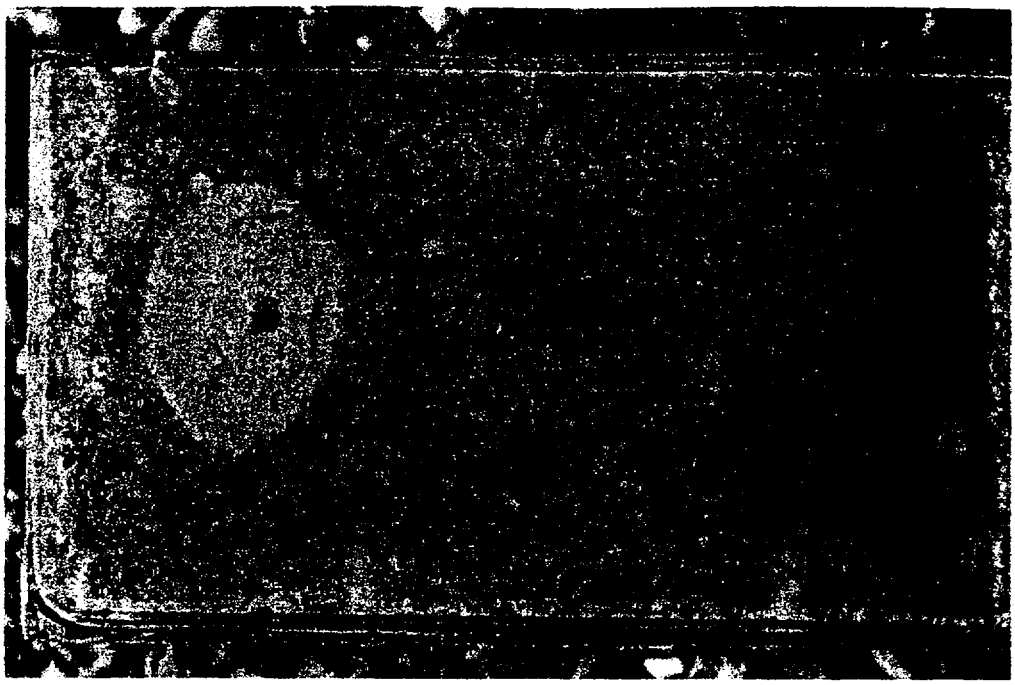
ALTERATION The following alteration features are present but of indeterminate relative ages: (1) calcite completely altered to dolomite; and (2) dolomite weakly altered to quartz.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS 98BA24-RS-11/98025/05/DAY/3X/HSI CLAYEY DOLOMITE showing typical appearance of hand specimen.

98BA24-RS-11/98025/18/XPL/114X/HSI CLAYEY DOLOMITE showing typical appearance of sparry dolomite, kaolinite (dark areas; K13), and angular quartz (I25) silt.

98BA24-RS-11/98025/19/XPL/28X/HSI CLAYEY DOLOMITE showing typical appearance of sparry dolomite, kaolinite (dark areas), and angular quartz (J6) silt.



98WT17-RS11

SAMPLE # 98WT17-RS11 October 13, 1998

ROCK NAME ALTERED SANDSTONE -- probably formed by alteration (secondary dolomite + quartz + FEOH) of a coarse to very coarse grained volcanic sandstone.

MINERALS Calcite (49%) + K-feldspar (25%) + dolomite (12%) + quartz (8%) + plagioclase (5%) + FEOH (1%).

TEXTURES Clastic sedimentary. Weakly developed bedding defines a weakly directed fabric.

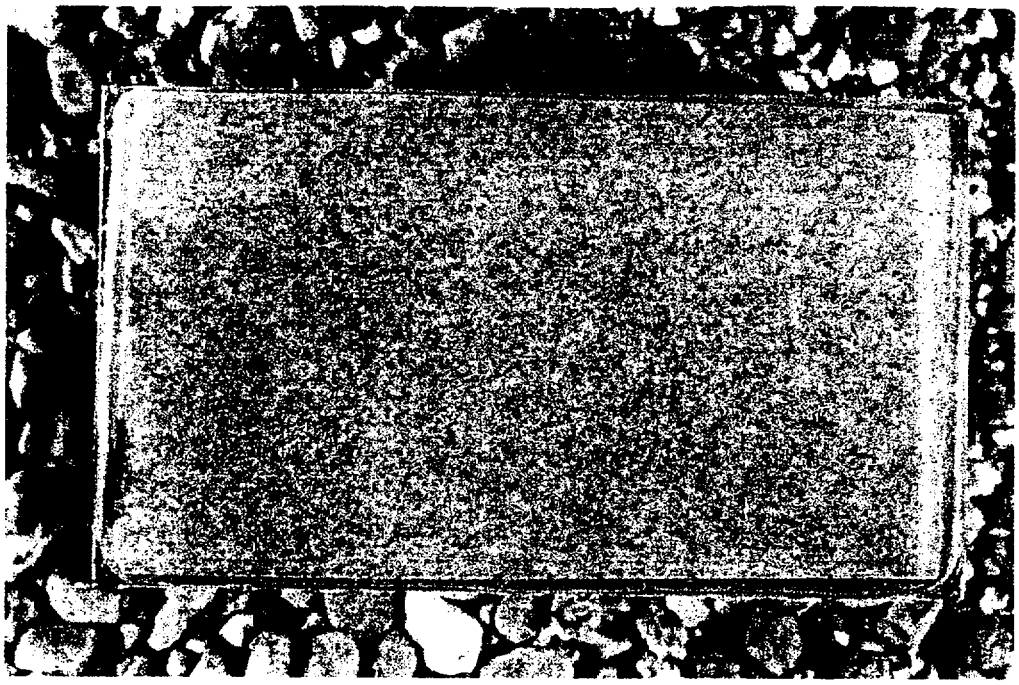
Detrital Framework Components (88%) are angular, 50-1000-12,000 μm, [rock fragments of trachyte/rhyolite porphyry (24%)] + monocrystalline [plagioclase (5%) + K-feldspar (1%) + quartz (8%)] + calcite fossil fragments (50%). Contacts between grains are floating to straight.

Matrix/Cement (12%) is composed of sparry dolomite.

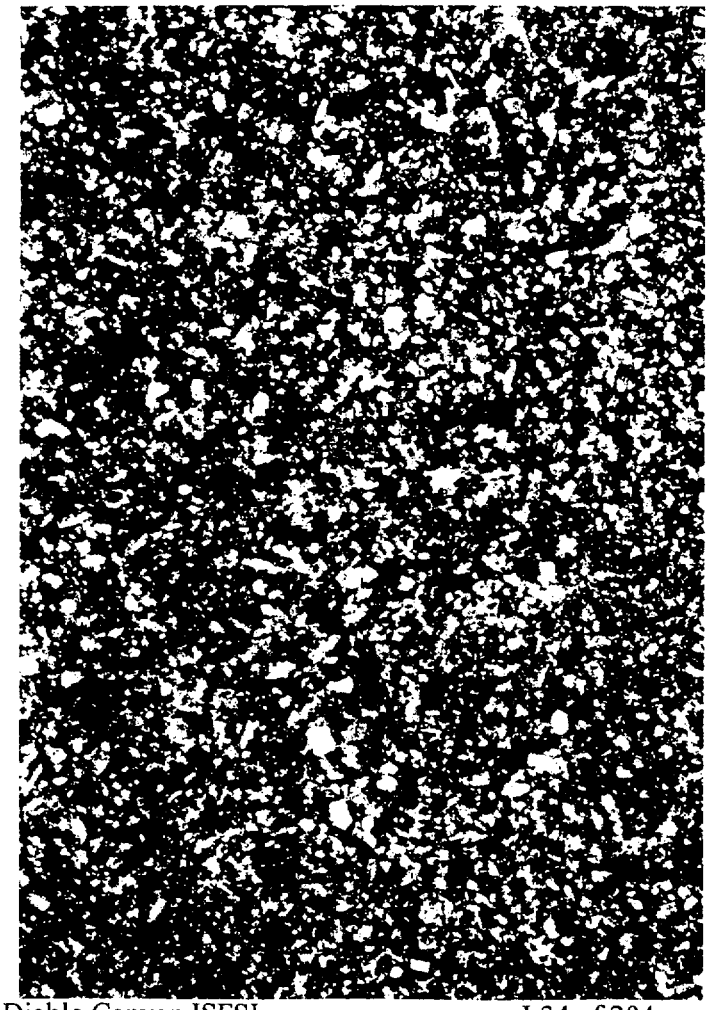
ALTERATION The following alteration features are present but of indeterminate relative ages: (1) calcite weakly altered to dolomite + quartz.

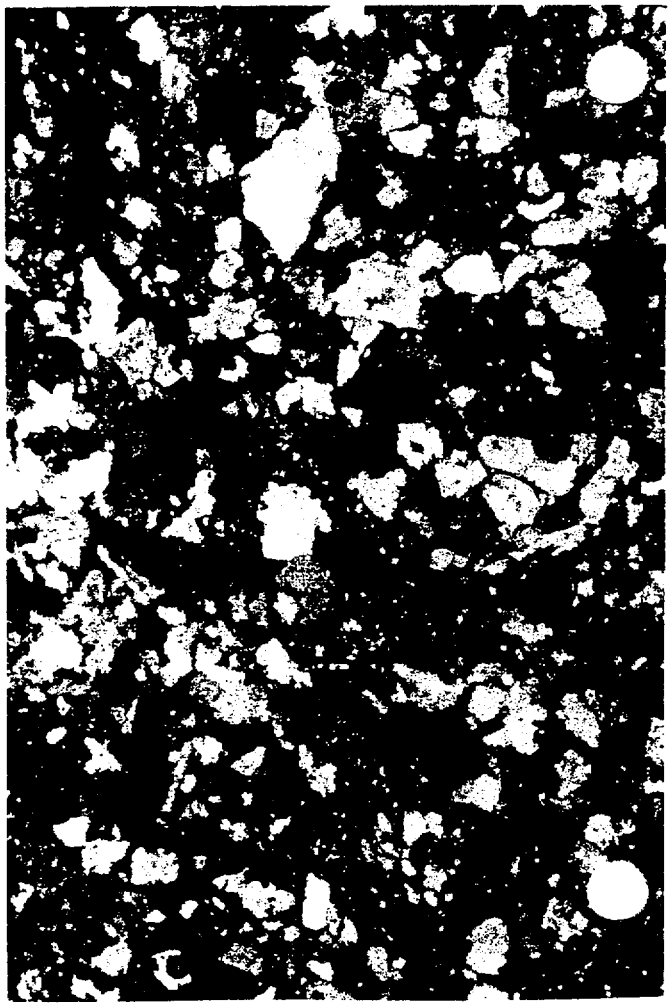
SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS 98WT17-RS11/98025/11/DAY/3X/HSI ALTERED SANDSTONE showing typical appearance of coarse fossil material in hand specimen.



98BA24-RS-11





SAMPLE # RS-12 October 13, 1998

ROCK NAME ALTERED TRACHYTE/RHYOLITE -- probably formed by devitrification and alteration (secondary clay + leucoxene + dolomite + FEOH) of a glassy (?) sparsely porphyritic trachyte/rhyolite flow. The lack of pumice or lithic fragments suggests a flow rather than pyroclastic origin.

MINERALS K-feldspar (44%) + clay (25%) + quartz (20%) + leucoxene (5%) + dolomite (3%) + FEOH (2%) + plagioclase (1%) + opaques (<1%).

TEXTURES Aphanitic, holocrystalline, sparsely porphyritic, very fine grained. Relict flow (?) structures define a weakly directed fabric.

Phenocrysts (2%) subhedral to euhedral, 20-100-200 μm, whole, isolated.

Quartz (1%)

Plagioclase (1%) -- weakly altered to clay.

Groundmass (98%) is microcrystalline [K-feldspar + quartz + [plagioclase strongly altered to clay]].

Vesicles (0%) and Xenoliths (0%) were not observed.

ALTERATION The following alteration features are also present but of indeterminate relative ages: (1) veins of dolomite; (2) and opaques completely altered to leucoxene.

SECTIONING Format: 27 x 46 mm Finish: POL Stains: None Cover: None

PHOTOS RS-12/98025/12/DAY/3X/HSI ALTERED TRACHYTE/RHYOLITE showing typical appearance of hand specimen.

RS-12/98025/22/XPL/57X/HSI ALTERED TRACHYTE/RHYOLITE showing typical appearance of sparse phenocrysts of quartz (G25) and plagioclase (L5).

RS-12/98025/23/PPL/28X/HSI ALTERED TRACHYTE/RHYOLITE showing typical closeup appearance of faint relict flow (?) texture in groundmass.

RS-12

SAMPLE # 98~~S~~WT10-RS~~0~~-9 STP per SCL October 13, 1998

ROCK NAME CLAYEY FOSSILIFERROUS DOLOMITE -- probably formed by alteration (secondary dolomite + FEOH) of a clayey fossiliferrous limestone protolith.

MINERALS Dolomite (83%) + clay (mostly kaolinite) (15%) + FEOH (2%) + quartz (<1%) + opaques (<1%).

TEXTURES Mixed chemical and clastic sedimentary. Weakly developed bedding defines a weakly directed fabric.

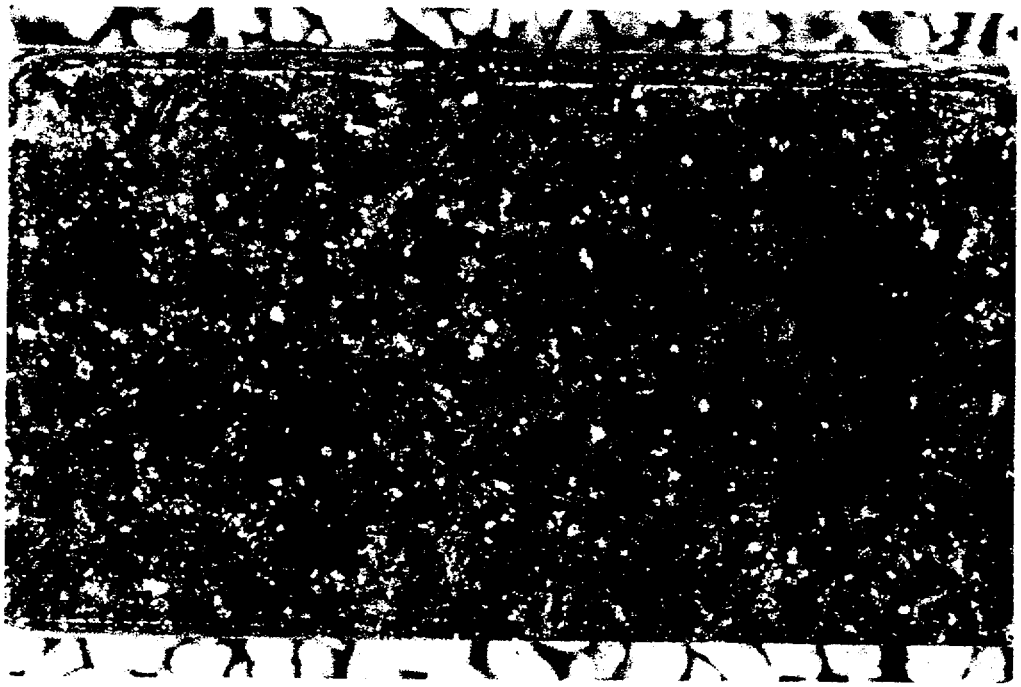
Detrital Framework Components (60%) are 40-250-480 μm dolomitic microfossils (60%) + angular quartz silt (<1%). Contacts between detrital framework components grains are floating to tangential.

Matrix/Cement (40%) is composed of sparry dolomite + FEOH-stained clay.

ALTERATION The following alteration features are also present but of indeterminate relative ages: (1) calcite completely altered to dolomite.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS 98ST10-RS9/98025/10/DAY/3X/HSI CLAYEY FOSSILIFERROUS DOLOMITE showing typical appearance of hand specimen.



98 WT9-RS6

SAMPLE # **98WT9-RS6** October 13, 1998

ROCK NAME ALTERED GABBRO/DIORITE -- probably formed by hydrothermal alteration (secondary brown clay) of a fine grained gabbro/diorite intrusive rock.

MINERALS Plagioclase (70%) + brown clay (probably chlorite + smectite) (15%) + clinopyroxene (10%) + opaques (5%).

TEXTURES Phaneritic, holocrystalline, equigranular, hypidiomorphic, fine grained, non-directed fabric.

ALTERATION The following alteration features are present but of indeterminate relative ages: (1) plagioclase weakly altered to brown clay; (2) clinopyroxene weakly altered to brown clay; and (3) olivine (?) completely weakly altered to brown clay.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS 98WT9-RS6/98025/08/DAY/3X/HSI ALTERED GABBRO/DIORITE showing typical appearance of hand specimen.

Spectrum Petrographics, Inc. 499 Dillard Gardens Road, Suite 2 · Winston · OR · 97496 · USA Phone (800) 625-2476

98 $T10-RS~~X~~-9

W

JTP per SCL

SAMPLE # 797-56 October 13, 1998

ROCK NAME CLAYEY DOLOMITE -- probably formed by alteration (secondary dolomite + FEOH + quartz) of a sparsely fossiliferrous clayey limestone protolith.

MINERALS Dolomite (90%) + clay (mostly kaolinite) (9%) + FEOH (1%) + quartz (<1%) + opaques (<1%).

TEXTURES Mixed chemical and clastic sedimentary. Weakly developed bedding defines a weakly directed fabric.

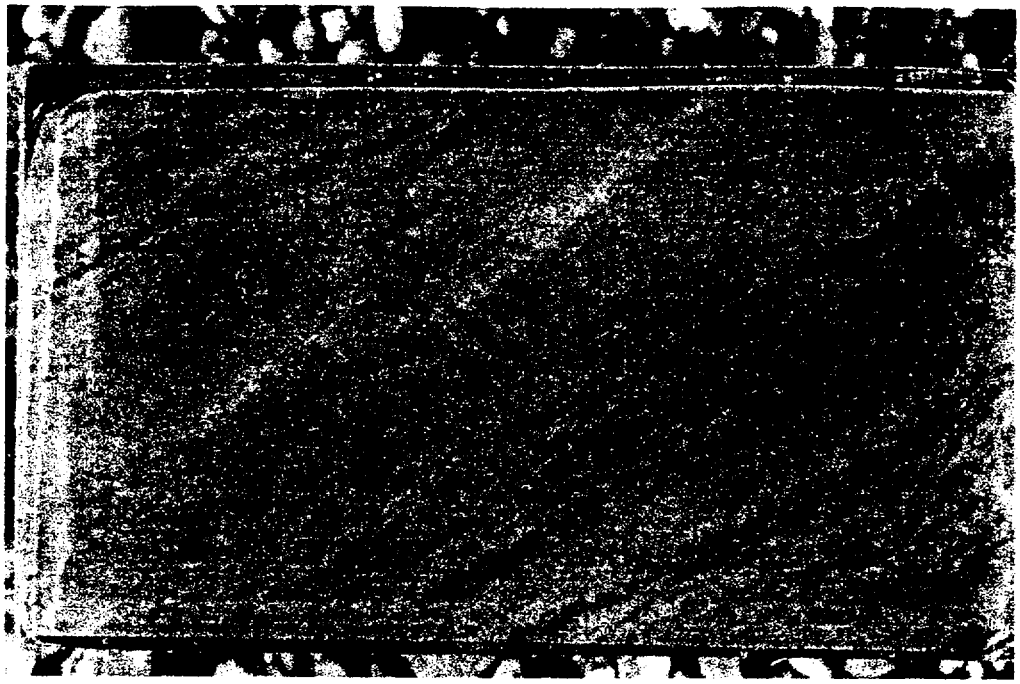
Detrital Framework Components (10%) are 70-120-520 μm dolomitic microfossils (10%) + angular quartz silt (<1%). Contacts between detrital framework components grains are floating.

Matrix/Cement (90%) is composed of fine sparry dolomite + FEOH-stained clay.

ALTERATION The following alteration features are present but of indeterminate relative ages: (1) calcite completely altered to dolomite; and (2) dolomite weakly altered to quartz.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS 797-56/98025/13/DAY/3X/HSI CLAYEY DOLOMITE showing typical appearance of hand specimen.



797-56

SAMPLE # 98WT9-RS7 October 13, 1998

ROCK NAME ALTERED GABBRO/DIORITE -- probably formed by hydrothermal alteration (secondary brown clay) of a fine grained gabbro/diorite intrusive rock.

MINERALS Plagioclase (50%) + brown clay (probably chlorite + smectite) (38%) + clinopyroxene (8%) + opaques (4%).

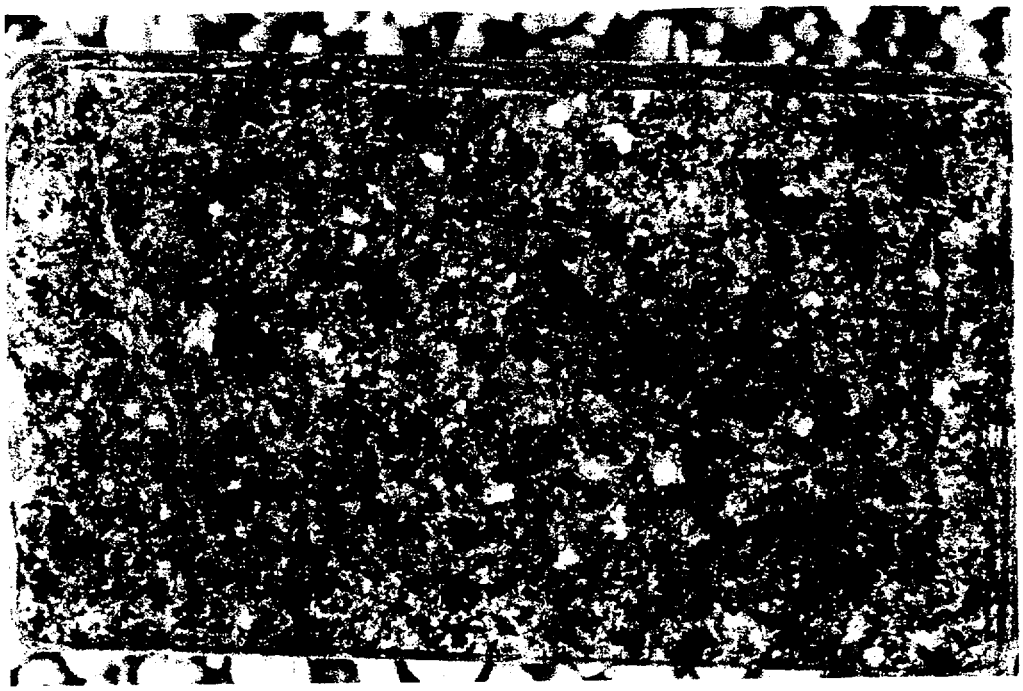
TEXTURES Phaneritic, holocrystalline, equigranular, hypidiomorphic, fine grained, non-directed fabric.

ALTERATION The following alteration features are present but of indeterminate relative ages: (1) plagioclase weakly altered to brown clay; (2) clinopyroxene weakly altered to brown clay; (3) olivine (?) completely weakly altered to brown clay; (4) veins of clay; and (5) veins of dolomite.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS 98WT9-RS7/98025/09/DAY/3X/HSI ALTERED GABBRO/DIORITE showing typical appearance of hand specimen.

Spectrum Petrographics, Inc. 499 Dillard Gardens Road, Suite 2 · Winston · OR · 97496 · USA Phone (800) 625-2476



98WT9-RS7

DATA REPORT J

ATTACHMENT 2

SPECTRUM PETROGRAPHICS, INC., REPORT ENTITLED "DCPP ISFSI SITE PROJECT PETROGRAPHIC REPORT #LBN"

DATED JUNE 27, 2001

DIABLO CANYON ISFSI

DCPP ISFSI SITE PROJECT

Petrographic Report #LBN

June 27, 2001

for

Mr. Jeff Bachhuber
William Lettis & Associates, Inc.
1777 Botelho Drive, Suite 262
Walnut Creek, CA 94596

by

Michael DePangher, Ph.D.
Spectrum Petrographics, Inc.

Comments

Most clay in these samples is cryptocrystalline and therefore not accurately identifiable by optical means alone. X-ray diffraction (XRD) studies of select samples were performed on select samples at the Energy & Geoscience Institute at the University of Utah. The results are discussed in this final report within the text of the petrographic mineralogy section of each relevant sample. Smectite and kaolinite are the dominant clay species identified by both XRD and petrography. Mineral abundances reported from XRD alone have no quantitative significance.

Many of these samples are mechanical mixtures of an apparently deep sea assemblage (siliceous sponge spicules + phosphorite) with a subaerial trachytic volcaniclastic phenocryst fragment assemblage (K-feldspar >> quartz >>> plagioclase). Hybrid bioclastic and volcaniclastic rocks such as these would most likely form by mechanical mixing as turbidity flows rich in shallow shelf and subaerial volcaniclastic debris sloughed off the continental shelf and mixed with deep sea pelagic sediment.

Most of the dolomite in these samples appears to be secondary. Much of it is in the form of disseminated euhedral rhombs that probably represent completely texture destructive replacement of calcitic fossil material. Formation of rhombic dolomite appears to be accompanied by development of a pseudo-granular hand specimen texture that looks like a sandstone. Fossil fragments and silicate phenocryst fragments are both observed to be replaced by texture destructive [porosity + sparry dolomite + kaolinite]. Probably a lot of the clay and kaolinite is secondary also.

Secondary dolomite + kaolinite + quartz suggests a low pH alteration assemblage equivalent to dolomite + sericite at slightly higher pH.

I would hypothesize a progressive alteration in these samples with least altered represented by:

1. calcitic bioclastic limestone with abundant forams (P-12, P-13)
2. progressive texture destructive replacement of calcite by granoblastic dolomite (P-1, P-2)
3. the most altered samples would be those with euhedral rhombic dolomite (P-3)

In this report, the rock name "limestone" implies that the protolith was a limestone dominated by primary calcite and/or aragonite. The term "carbonate" is herein applied to samples that are now mostly dolomite but were probably derived by alteration from a limestone protolith. In my 1998 report (Spectrum job # HSI) I applied the rock name "dolomite" to these altered rocks and indicated that they were probably derived from a sparsely fossiliferous clayey limestone protolith.

Key to Petrographic and Photomicrographic Descriptions

Clay minerals common in altered rocks must often be identified by X-ray diffraction either because their optic properties are not diagnostic or because they are too fine grained to be reliably identified by optical methods. The term "clay" is used herein to denote fine grained phyllosilicates in general. Under ideal conditions, it is often possible to optically discriminate between 4 major groups: kaolinite, smectite, mica (including illite), and chlorite. This is done whenever conditions permit.

The term "sericite" is applied to fine grained colorless phyllosilicates that show upper 2nd order maximum interference colors. These could include muscovite, illite, paragonite, lepidolite, margarite, clintonite, pyrophyllite, and talc. The term "intermediate clay" is applied to fine grained very pale or colorless phyllosilicates that show upper 1st order maximum interference colors. These are probably dominated by chlorite, smectite, and mixed-layer illite/smectite.

The term "opaques" is used to refer to all materials opaque (and sometimes semi-opaque) to transmitted light. The term "FEOH" is herein used to indicate fine grained, yellowish to reddish brown, earthy materials of varying opacity in transmitted light. FEOH is probably mostly Fe oxy-hydroxides but may sometimes include sphalerite, realgar, orpiment, jarosite, a number of Mn oxy-hydroxides, and organic matter.

Particle size distributions are given as (A-B-C µm), where A, B, and C are the smallest, median, and largest particle sizes, respectively, in microns. A question mark (?) in the position of A, B, or C indicates that the value of A, B, or C was indeterminate, probably because of excessively large or small particle size or statistically insignificant numbers of particles.

Mineral abundances are visual estimates. For multi-lithologic materials (cuttings, etc...), mineralogy, textures, and alteration are described only for the dominant lithology.

Section preparation codes are as follows: (1) Format: 27 x 46 mm, 51 x 76 mm, or 1" round; (2) Finish: standard lapping (STD) or polished (POL); (3) Stains: sodium cobaltinitrite (SCN), alizarin red S (ARS), potassium ferricyanide (PF), and barium chloride + potassium rhodizonate (BCPR); and (4) Cover: none, permanent Loctite acrylic (PLA), or removable Canada Balsam (RCB).

Photomicrograph captions/labels contain the following items of information in consecutive order separated by forward slashes: (1) sample identification, (2) film roll number, (3) frame number, (4) type of illumination, (5) field of view (FOV) <u>or</u> the magnification on the color print, which is given as the number of times actual size (ie., 32X), and (6) the job identification number. "PPL" indicates plane-polarized light; "XPL indicates cross-polarized light. "R" indicates reflected light. "550" means that a 550 nanometer wavelength plate was inserted in the light path. "C" indicates that the substage condenser was <u>in</u> (sometimes used for Fe-oxides). "O" indicates substage condenser in an oblique position. These various illuminations can be combined. "CON" indicates conoscopic illumination. For normal photography of hand specimens, the focal length of the lens used is given rather than the magnification. POL means that a polarizing filter was used with the lens, and DAY means the sample was photographed in diffused daylight.

Features on photomicrographs can be located by overlaying the accompanying orthogonal plastic grid. A block of squares is marked by referencing the uppermost left and lowermost right corners of the block, ie. A6-E15. Linear features are marked by designating the extent of the feature from beginning to ending points, ie. B6 to L19.

A question mark after a rock or mineral name in a petrographic description means that there is some degree of uncertainty about the identification of that rock or mineral.

The size of an alteration selvege around a vein is given as a half-width (the width of a selvege on one side of the vein) expressed as a fraction of the associated vein width (vw).

SAMPLE # **P-1** June 27, 2001

ROCK NAME ALTERED CLAYEY CARBONATE -- probably formed by alteration (secondary dolomite + clay) of a clayey fossiliferous limestone protolith.

MINERALS Dolomite (70%) + clay (probably smectite) (15%) + calcite (10%) + quartz (5%) + K-feldspar (<1%) + plagioclase (<1%) + zircon (<1%).

TEXTURES Dominantly clastic sedimentary; non-directed fabric.

Detrital Framework Grains (15%) are [angular, 10-30-320 μm, quartz (5%) + K-feldspar (<1%) + plagioclase (<1%) + zircon (<1%)] + calcitic microfossils (foraminifera ?) (10%) + sponge spicules (<1%). Contacts between grains are floating.

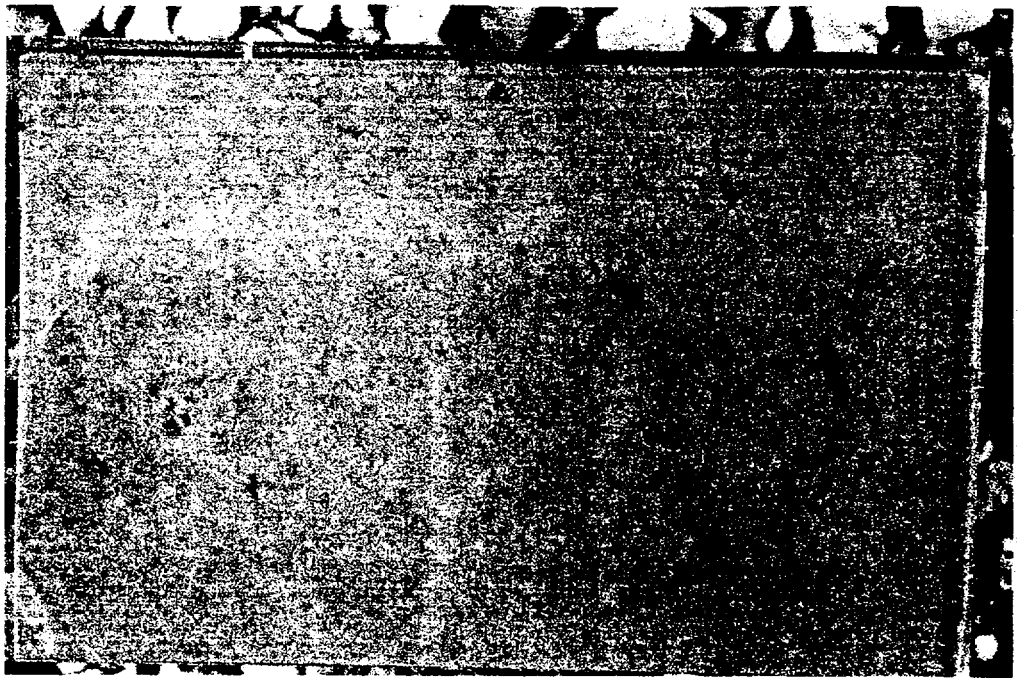
Matrix/Cement (85%) is composed of fine granoblastic dolomite + clay.

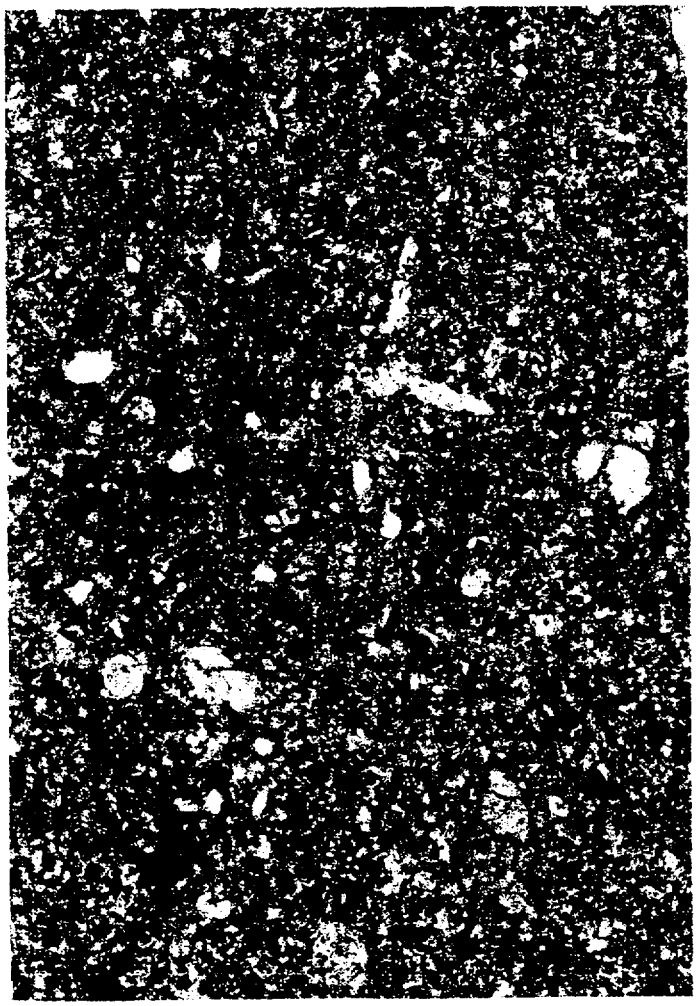
ALTERATION Alteration features in relative chronological order from oldest to youngest are: (1) sparse veinlets of clay.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-1/01013/01/DAY/3X/LBN ALTERED CLAYEY CARBONATE showing typical appearance of hand specimen.

P-1/01015/01/XPL/57X/LBN ALTERED CLAYEY CARBONATE showing typical appearance of detrital quartz (C19), coiled forams (?) (D10, G10, R16), and sponge spicules (L21) in matrix/cement dominated by granoblastic dolomite.





P-1

SAMPLE # **P-2** June 27, 2001

ROCK NAME ALTERED CLAYEY CARBONATE -- probably formed by alteration (secondary dolomite + FEOH) of a clayey fossiliferous limestone protolith.

MINERALS Dolomite (68%) + clay (probably smectite) (20%) + calcite (5%) + quartz (5%) + opaques (1%) + FEOH (1%) + K-feldspar (<1%) + plagioclase (<1%) + zircon (<1%).

TEXTURES Dominantly chemical sedimentary; non-directed fabric.

Detrital Framework Grains (11%) are [angular, 10-50-1720 μm quartz (5%) + K-feldspar (<1%) + plagioclase (<1%) + zircon (<1%)] + calcitic microfossils (foraminifera ?) (5%) + [lithic fragments (1%) of claystone (1%)+ chert (<1%)]. Contacts between grains are floating.

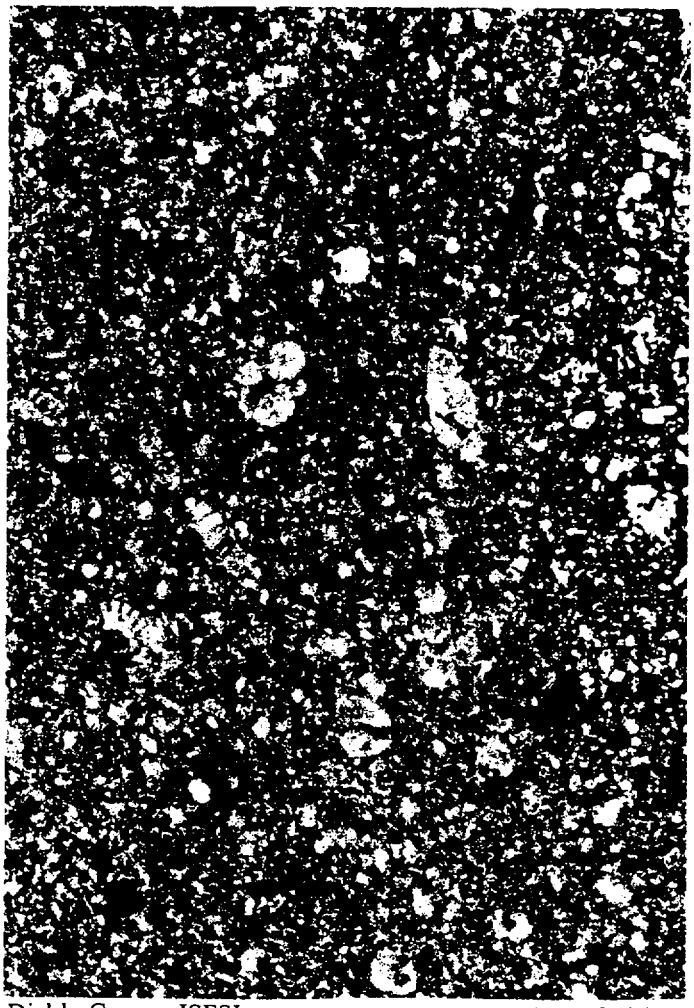
Matrix/Cement (89%) is composed of fine granoblastic dolomite + clay.

ALTERATION Alteration features in relative chronological order from oldest to youngest are: (1) opaques moderately altered to FEOH.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-2/01013/02/DAY/3X/LBN ALTERED CLAYEY CARBONATE showing typical appearance of hand specimen.

P-2/01015/02/XPL/57X/LBN ALTERED CLAYEY CARBONATE showing typical appearance of coiled forams (?) (G14, H19) in matrix/cement dominated by granoblastic dolomite.



P-2

SAMPLE # **P-3** June 27, 2001

ROCK NAME ALTERED CLAYEY CARBONATE -- probably formed by alteration (secondary dolomite) of a clayey limestone protolith.

MINERALS Dolomite (50%) + clay (probably smectite) (22%) + kaolinite (15%) + quartz (10%) + opaques (3%).

TEXTURES Dominantly clastic sedimentary; non-directed fabric.

Detrital Framework Grains (10%) are sponge spicules (9%) + [angular, 20-70-800 μm quartz (1%)]. Contacts between grains are floating.

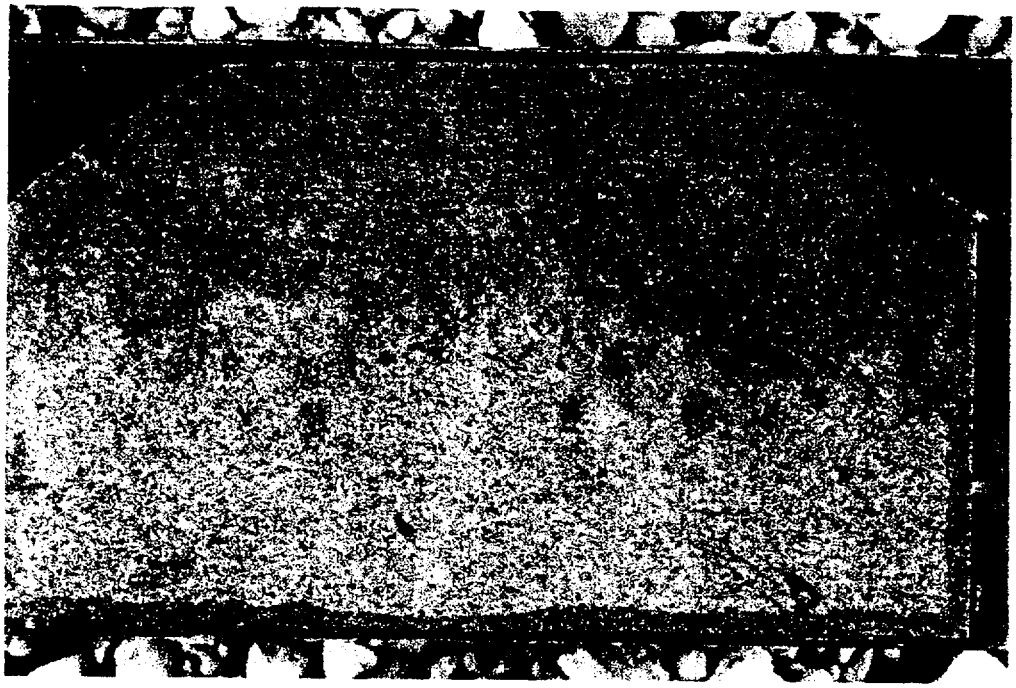
Matrix/Cement (90%) is composed of dolomite (euhedral rhombs) + clay + kaolinite.

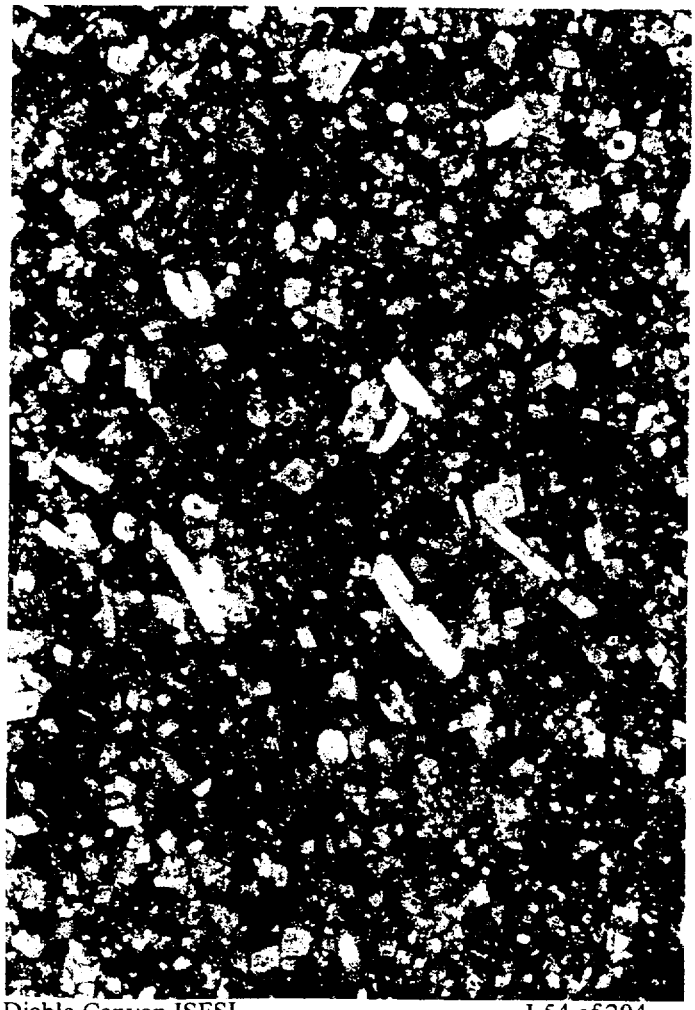
ALTERATION No other alteration features were observed.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-3/01013/03/DAY/3X/LBN ALTERED CLAYEY CARBONATE showing typical appearance of hand specimen.

P-3/01015/03/XPL/57X/LBN ALTERED CLAYEY CARBONATE showing typical appearance of sponge spicules (J8, M11) in matrix/cement of euhedral dolomite rhombs (I16, O15) + clay + kaolinite (F18).





P-3

SAMPLE # **P-4** June 27, 2001

ROCK NAME ALTERED SANDSTONE -- probably formed by alteration (secondary dolomite + kaolinite + clay + quartz) of a fine lithic arkose (McBride, 1963) dominantly volcaniclastic protolith.

MINERALS K-feldspar (25%) + dolomite (20%) + kaolinite (20%) + clay (18%) + quartz (15%) + opaques (2%) + plagioclase (<1%) + zircon (<1%).

TEXTURES Clastic sedimentary; non-directed fabric.

Detrital Framework Grains (50%) are [angular, 50-200-2000 μm, K-feldspar (25%) + quartz (7%) + plagioclase (<1%) + zircon (<1%)] + sponge spicules (7%) + [lithic fragments (10%) of trachyte moderately altered to kaolinite + clay]. Contacts between grains are tangential.

Matrix/Cement (15%) is dominated by dolomite + kaolinite + clay.

ALTERATION The following alteration features are present but of indeterminate relative ages: (1) veinlets of dolomite; (2) K-feldspar moderately altered to clay; and (3) volcanic glass (?) completely altered to dolomite + kaolinite + quartz.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-4/01013/04/DAY/3X/LBN ALTERED SANDSTONE showing typical appearance of hand specimen.

P-4/01015/04/XPL/28X/LBN ALTERED SANDSTONE showing typical appearance of with abundant altered volcaniclastic debris (same view as 01015/05).

P-4/01015/05/PPL/28X/LBN ALTERED SANDSTONE showing typical appearance of with abundant altered volcaniclastic debris (same view as 01015/04).

P-4

AMPLE # **P-5** June 27, 2001

ROCK NAME ALTERED SANDSTONE -- probably formed by alteration (secondary dolomite + kaolinite + clay) of a medium feldspathic litharenite (McBride, 1963) dominantly volcaniclastic protolith (resembles P-14).

MINERALS Dolomite (45%) + clay (30%) + kaolinite (10%) + quartz (10%) + K-feldspar (5%) + plagioclase (<1%) + opaques (<1%) + FEOH (<1%).

TEXTURES Clastic sedimentary; non-directed fabric.

Detrital Framework Grains (35%) are [angular, 120-400-800 μm, quartz (9%) + K-feldspar (5%) + plagioclase (<1%)] + sponge spicules (1%) + [lithic fragments (20%) of altered trachyte + chert]. Contacts between grains are floating to tangential.

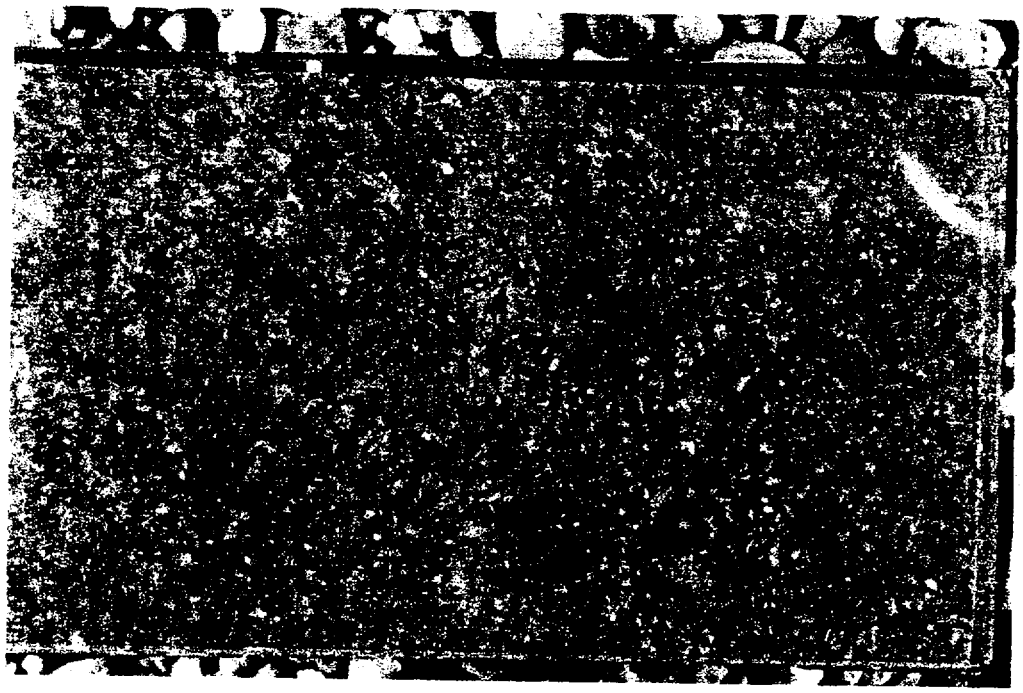
Matrix/Cement (65%) is dominated by dolomite + clay + kaolinite.

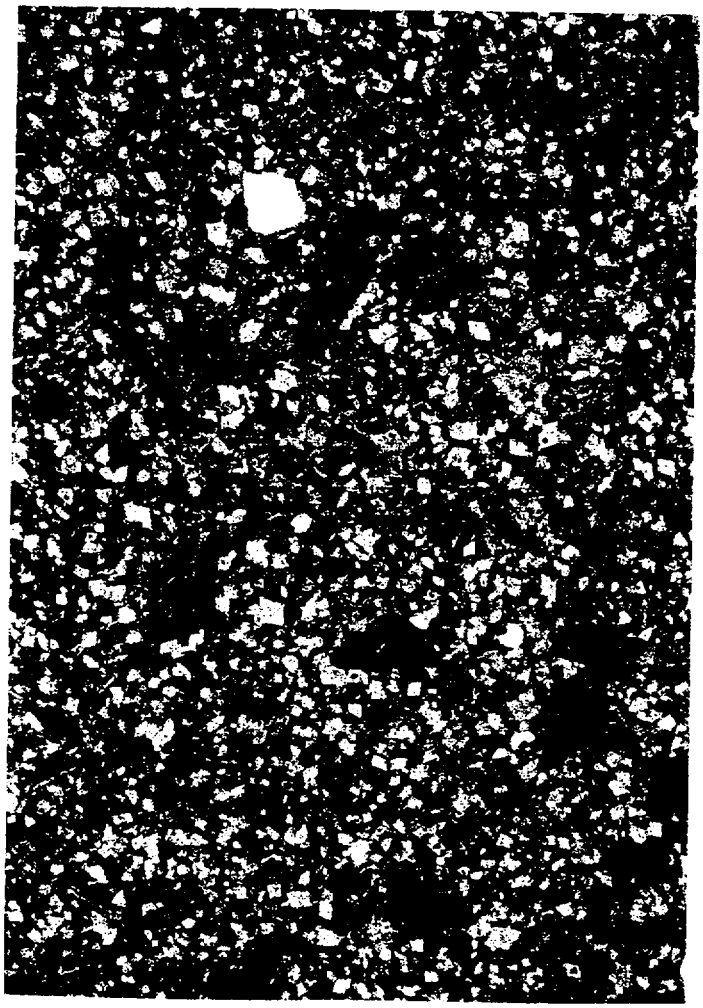
ALTERATION The following alteration features are present but of indeterminate relative ages: (1) K-feldspar moderately altered to clay; (2) trachyte (?) lithic fragments strongly altered to clay; (3) an indeterminate reaction relationship between clay and kaolinite; and (4) opaques moderately altered to FEOH.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

HOTOS P-5/01013/05/DAY/3X/LBN ALTERED SANDSTONE showing typical appearance of hand specimen with boundary between oxidized (red) and unoxidized (gray) sample.

P-5/01015/06/XPL/28X/LBN ALTERED SANDSTONE showing typical appearance of clastic detritus scattered throughout matrix/cement dominated by euhedral dolomite rhombs.





P-5

SAMPLE # **P-6** June 27, 2001

ROCK NAME ALTERED SANDSTONE -- probably formed by alteration (secondary K-feldspar + dolomite + clay + kaolinite + FEOH) of a medium lithic arkose (McBride, 1963) dominantly volcaniclastic protolith.

MINERALS K-feldspar (30%) + dolomite (21%) + clay (21%) + kaolinite (15%) + quartz (10%) + FEOH (2%) + plagioclase (1%) + apatite (<1%). Bulk XRD has identified smectite + quartz + K-feldspar + dolomite + kaolinite + pyrite (?) + goethite + amorphous material, suggesting that undifferentiated clay in this sample is dominantly smectite.

TEXTURES Clastic sedimentary; non-directed fabric.

Detrital Framework Grains (40%) are [angular, 80-360-1200 μm, K-feldspar (25%) + quartz (6%) + plagioclase (1%)] + sponge spicules (3%) + [lithic fragments (5%) of altered trachyte + chert + phosphorite]. Contacts between grains are tangential.

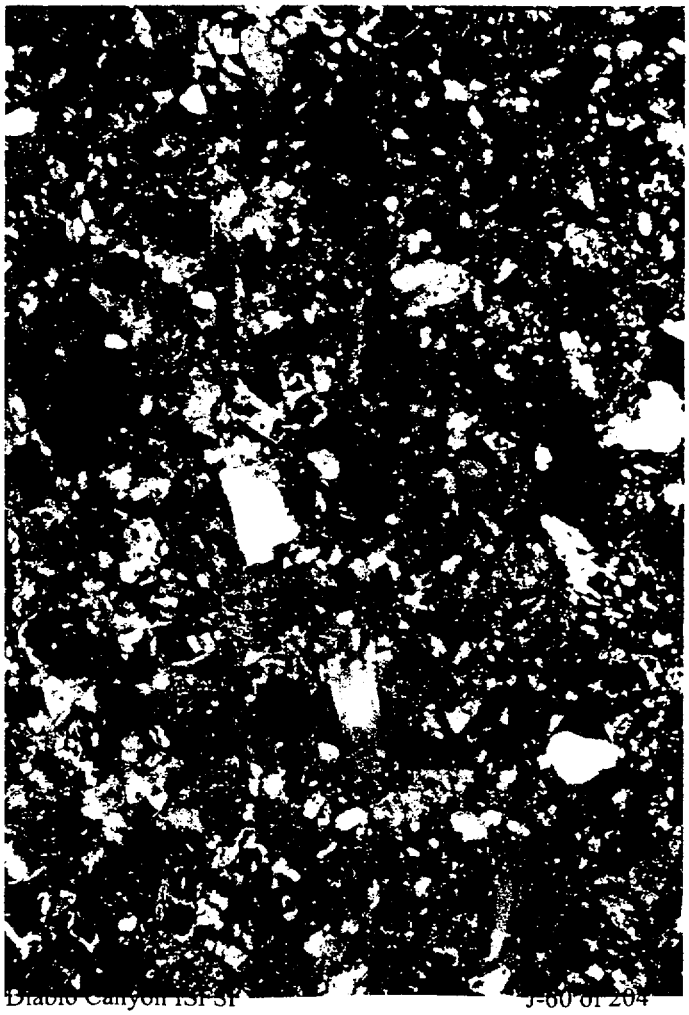
Matrix/Cement (60%) is dominated by dolomite + clay + kaolinite.

ALTERATION The following alteration features are present but of indeterminate relative ages: (1) volcanic glass (?) completely altered to kaolinite + dolomite + K-feldspar; (2) opaques completely altered to FEOH; and (3) K-feldspar strongly altered to porosity + dolomite.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-6/01013/06/DAY/3X/LBN ALTERED SANDSTONE showing typical appearance of hand specimen.

P-6/01015/07/XPL/28X/LBN ALTERED SANDSTONE showing typical appearance of abundant phenocryst fragments dominated by [K-feldspar strongly altered to porosity + dolomite] (F5, H18, R13).



P-6

SAMPLE # **P-7** June 27, 2001

ROCK NAME ALTERED CLAYEY CARBONATE -- probably formed by alteration (secondary dolomite + FEOH) of a clayey limestone protolith.

MINERALS Dolomite (40%) + kaolinite (37%) + quartz (10%) + clay (probably smectite) (10%) + FEOH (3%) + K-feldspar (<1%) + plagioclase (<1%).

TEXTURES Dominantly clastic sedimentary; non-directed fabric.

Detrital Framework Grains (11%) are sponge spicules (5%) + [angular, 10-50-190 μm quartz (5%) + K-feldspar (<1%) + plagioclase (<1%)] + lithic fragments (1%) of claystone. Contacts between grains are floating.

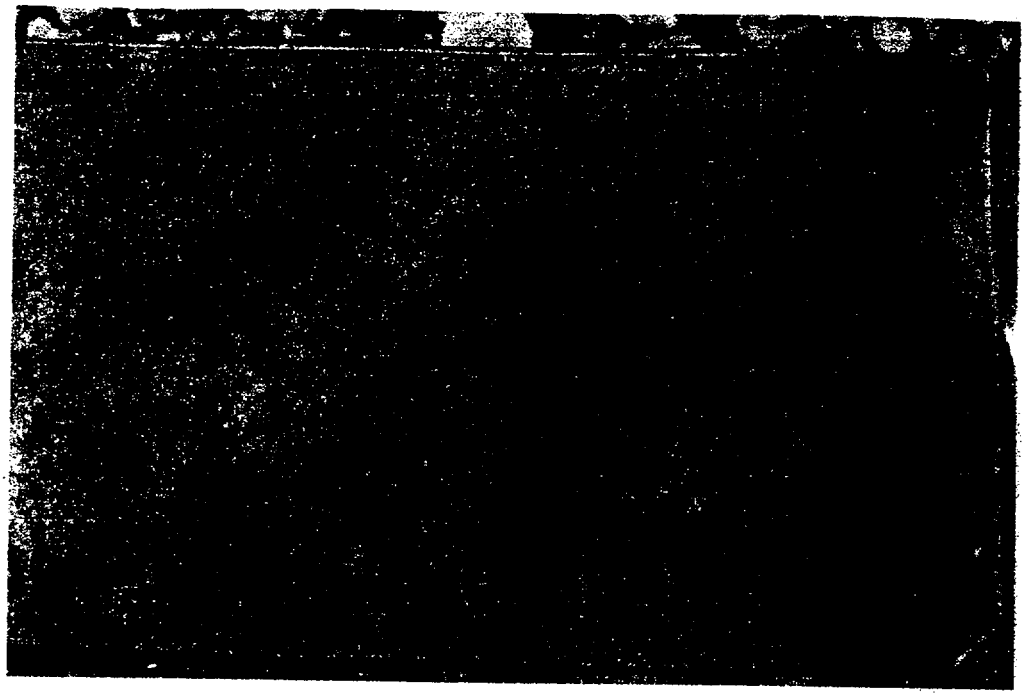
Matrix/Cement (89%) is dominated by sparry subhedral dolomite + kaolinite + clay.

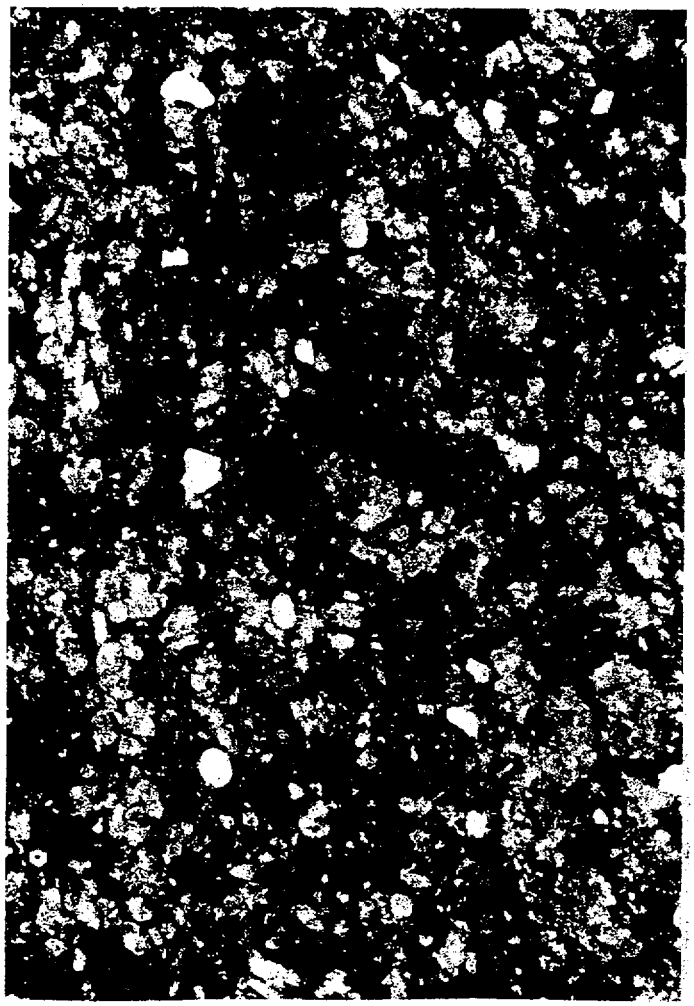
ALTERATION No other alteration features were observed.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-7/01013/07/DAY/3X/LBN ALTERED CLAYEY CARBONATE showing typical appearance of hand specimen.

P-7/01015/08/XPL/57X/LBN ALTERED CLAYEY CARBONATE showing typical appearance of sparse clastic detritus in matrix/cement dominated by sparry subhedral dolomite + kaolinite + clay.





P-7

SAMPLE # **P-8** June 27, 2001

ROCK NAME ALTERED SILTSTONE -- probably formed by alteration (secondary kaolinite + clay + FEOH) of a mixed bioclastic and volcaniclastic siltstone protolith.

MINERALS Kaolinite (38%) + clay (20%) + K-feldspar (20%) + quartz (15%) + FEOH (4%) + plagioclase (1%) + apatite (1%) + opaques (1%) + hornblende (<1%).

TEXTURES Clastic sedimentary. Fine bedding in hand specimen defines a weakly directed fabric.

Detrital Framework Grains (38%) are [angular, 10-60-480 μm, K-feldspar (20%) + quartz (8%) + plagioclase (1%) + hornblende (<1%)] + sponge spicules (7%) + [lithic fragments (2%) of phosphorite + metapelite]. Contacts between grains are floating to tangential.

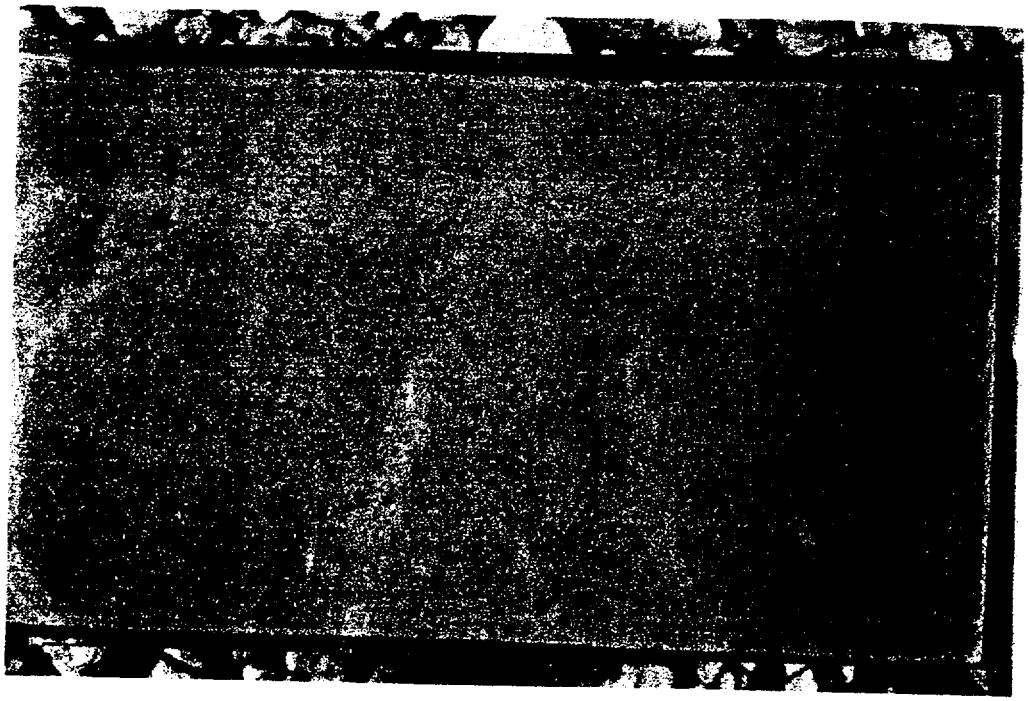
Matrix/Cement (62%) is dominated by kaolinite + clay.

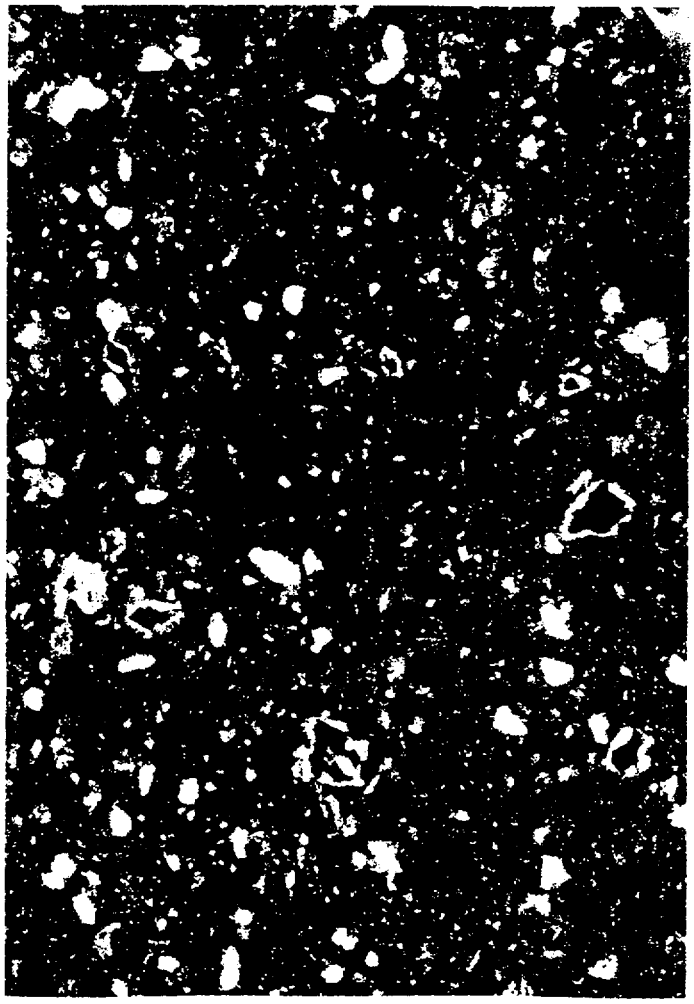
ALTERATION The following alteration features are present but of indeterminate relative ages: (1) volcanic glass (?) completely altered to kaolinite + clay; (2) opaques strongly altered to FEOH; and (3) K-feldspar strongly altered to porosity + dolomite.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-8/01013/08/DAY/3X/LBN ALTERED SILTSTONE showing typical appearance of fine bedding in hand specimen.

P-8/01015/09/XPL/57X/LBN ALTERED SILTSTONE showing typical appearance of abundant volcaniclastic debris dominated by [K-feldspar phenocryst fragments strongly altered to porosity + dolomite] (J8, E12, R15) in a matrix dominated by kaolinite + clay.





P-8

SAMPLE # **P-9** June 27, 2001

ROCK NAME ALTERED CALCAREOUS CLAYSTONE BRECCIA -- probably formed by cataclastic brecciation and alteration (secondary dolomite + FEOH) of a calcareous claystone protolith.

MINERALS Clay (44%) + dolomite (40%) + quartz (10%) + FEOH (3%) + calcite (2%) + apatite (1%) + plagioclase (<1%). Bulk XRD has identified quartz + dolomite + smectite + calcite + K-feldspar + kaolinite + apatite (?) + plagioclase + goethite + substantial amorphous material. XRD thus suggests that undifferentiated clay in this sample is composed of smectite + kaolinite.

TEXTURES Cataclastically brecciated; non-directed fabric.

Breccia Clasts are subround, ?-?-15,000 µm, lithic fragments of altered calcareous claystone. Contacts between breccia clasts are curved.

Matrix is composed of the altered comminuted equivalent of the clasts, suggesting a dominantly cataclastic mechanism of brecciation.

ALTERATION The following alteration features are present but of indeterminate relative ages: (1) cataclastic deformation; (2) veins of calcite + dolomite; (3) K-feldspar strongly altered to porosity + dolomite; and (4) opaques completely to FEOH.

ECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-9/01013/09/DAY/3X/LBN ALTERED CALCAREOUS CLAYSTONE BRECCIA showing typical appearance of deformation in hand specimen.

P-9/01015/10/XPL/28X/LBN ALTERED CALCAREOUS CLAYSTONE BRECCIA showing typical appearance.

P-9

SAMPLE # **P-10** June 27, 2001

ROCK NAME ALTERED SANDSTONE -- probably formed by alteration (secondary dolomite + kaolinite) of a fine lithic arkose (McBride, 1963) dominantly volcaniclastic protolith.

MINERALS K-feldspar (35%) + dolomite (20%) + clay (19%) + quartz (15%) + kaolinite (5%) + opaques (3%) + calcite (2%) + plagioclase (1%). Bulk XRD has identified smectite + quartz + dolomite + K-feldspar + kaolinite + plagioclase + pyrite + calcite + substantial amorphous material. XRD thus suggests that undifferentiated clay in this sample is dominantly smectite.

TEXTURES Clastic sedimentary; non-directed fabric.

Detrital Framework Grains (50%) are [angular, 40-200-880 μm, K-feldspar (35%) + quartz (8%) + plagioclase (1%)] + sponge spicules (1%) + [lithic fragments (5%) of altered trachyte + metapelite]. Contacts between grains are tangential.

Matrix/Cement (50%) is dominated by dolomite + clay + kaolinite.

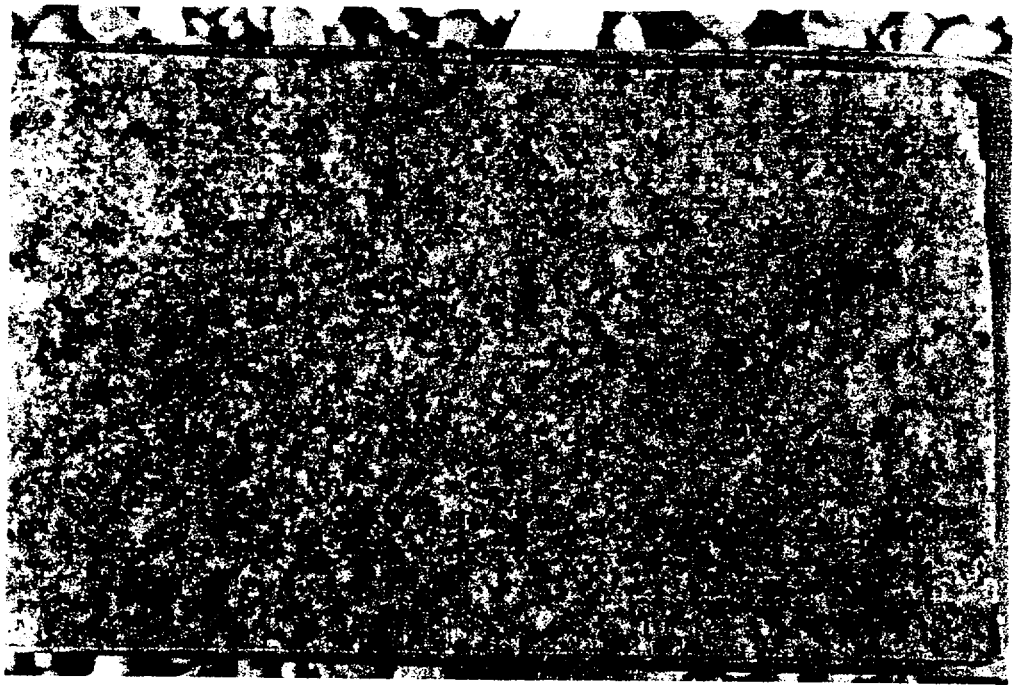
ALTERATION The following alteration features are present but of indeterminate relative ages: (1) K-feldspar strongly altered to porosity + kaolinite + dolomite; and (2) veinlets of calcite.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-10/01013/10/DAY/3X/LBN ALTERED SANDSTONE showing typical appearance of hand specimen.

P-10/01015/11/XPL/28X/LBN ALTERED SANDSTONE showing typical appearance of abundant volcaniclastic debris dominated by [K-feldspar phenocryst fragments strongly altered to porosity + kaolinite + dolomite] (H10, K10, J23).

P-10/01015/12/XPL/114X/LBN ALTERED SANDSTONE showing typical closeup appearance of a [K-feldspar phenocryst fragment (J14) strongly altered to porosity (K11) + kaolinite (N9) + dolomite (L18)].



P-10

SAMPLE # **P-11** June 27, 2001

ROCK NAME ALTERED CLAYEY CARBONATE -- probably formed by alteration (secondary dolomite + FEOH) of a clayey limestone protolith.

MINERALS Dolomite (55%) + clay (15%) + kaolinite (13%) + quartz (10%) + FEOH (4%) + K-feldspar (3%) + plagioclase (<1%) + opaques (<1%). Bulk XRD has identified dolomite + quartz + K-feldspar + kaolinite + plagioclase + smectite + goethite + substantial amorphous material. XRD thus suggests that undifferentiated clay in this sample is dominantly smectite.

TEXTURES Dominantly clastic sedimentary; non-directed fabric.

Detrital Framework Grains (13%) are [angular, 50-100-240 μm quartz (6%) + K-feldspar (3%) + plagioclase (<1%)] + sponge spicules (4%) + carbonate fossil fragments (foraminifera) (<1%). Contacts between grains are floating.

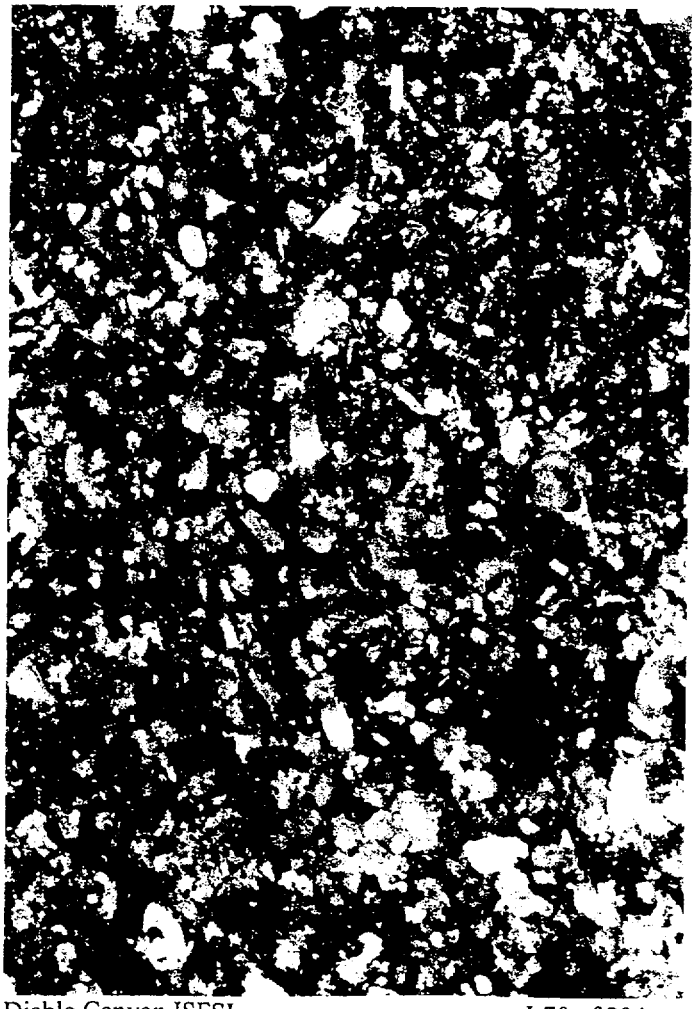
Matrix/Cement (87%) is dominated by sparry subhedral dolomite + clay + kaolinite.

ALTERATION The following alteration features are also present but of indeterminate relative ages: (1) opaques strongly altered to FEOH; and (2) original calcite (?) fossil fragments strongly altered to dolomite.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-11/01013/11/DAY/3X/LBN ALTERED CLAYEY CARBONATE showing typical appearance of hand specimen.

P-11/01015/13/XPL/57X/LBN ALTERED CLAYEY CARBONATE showing typical appearance of sparse clastic detritus in matrix/cement of sparry subhedral dolomite + clay + kaolinite.



P-11

SAMPLE # **P-12** June 27, 2001

ROCK NAME ALTERED BIOCLASTIC LIMESTONE -- probably formed by alteration (secondary dolomite + FEOH) of a bioclastic limestone protolith.

MINERALS Calcite (50%) + dolomite (15%) + brown clay (10%) + quartz (10%) + kaolinite (6%) + K-feldspar (5%) + FEOH (4%) + plagioclase (<1%) + apatite (<1%).

TEXTURES Dominantly clastic sedimentary; non-directed fabric.

Detrital Framework Grains (65%) are [angular, 30-100-480 μm quartz (8%) + K-feldspar (5%) + plagioclase (<1%)] + sponge spicules (2%) + calcite fossil fragments (spiral and spherical foraminifera) (50%) + lithic fragments (<1%) of phosphorite. Contacts between grains are tangential.

Matrix/Cement (35%) is dominated by dolomite + clay + kaolinite.

ALTERATION The following alteration features are also present but of indeterminate relative ages: (1) opaques completely altered to FEOH; (2) calcite fossil fragments weakly altered to dolomite; and (3) a single vein of FEOH.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-12/01013/12/DAY/3X/LBN ALTERED BIOCLASTIC LIMESTONE showing typical appearance of hand specimen.

P-12/01015/14/XPL/57X/LBN ALTERED BIOCLASTIC LIMESTONE showing typical appearance dominated by calcite fossil fragments (stained red; spiral and spherical forams (?)).

P-12

SAMPLE # **P-13** June 27, 2001

ROCK NAME ALTERED BIOCLASTIC LIMESTONE -- probably formed by alteration (secondary dolomite + FEOH) of a bioclastic limestone protolith.

MINERALS Calcite (50%) + dolomite (15%) + brown clay (15%) + quartz (10%) + kaolinite (5%) + FEOH (3%) + K-feldspar (2%) + plagioclase (<1%). + apatite (<1%).

TEXTURES Dominantly clastic sedimentary; non-directed fabric.

Detrital Framework Grains (62%) are [angular, 20-120-2800 μm quartz (8%) + K-feldspar (2%) + plagioclase (<1%)] + sponge spicules (2%) + calcite fossil fragments (spiral and spherical foraminifera) (50%) + lithic fragments (<1%) of phosphorite. Contacts between grains are tangential.

Matrix/Cement (38%) is dominated by dolomite + clay + kaolinite.

ALTERATION The following alteration features are also present but of indeterminate relative ages: (1) opaques completely altered to FEOH; and (2) calcite fossil fragments weakly altered to dolomite.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-13/01013/13/DAY/3X/LBN ALTERED BIOCLASTIC LIMESTONE showing typical appearance of hand specimen.

P-13/01015/15/XPL/57X/LBN ALTERED BIOCLASTIC LIMESTONE showing typical appearance dominated by calcite fossil fragments (stained red; spiral and spherical forams (?)).

P-13

SAMPLE # **P-14** June 27, 2001

ROCK NAME ALTERED SANDY CARBONATE -- probably formed by alteration (secondary dolomite + FEOH + kaolinite) of a sandy limestone protolith (resembles P-5).

MINERALS Dolomite (61%) + brown clay (13%) + quartz (10%) + kaolinite (8%) + K-feldspar (7%) + FEOH (2%) + plagioclase (<1%).

TEXTURES Dominantly clastic sedimentary; non-directed fabric.

Detrital Framework Grains (37%) are [angular, 40-400-1200 μm quartz (1%) + K-feldspar (2%) + plagioclase (<1%)] + sponge spicules (9%) + [altered glass shards or fish bones] (20%) + lithic fragments (5%) of altered trachyte. Contacts between grains are floating.

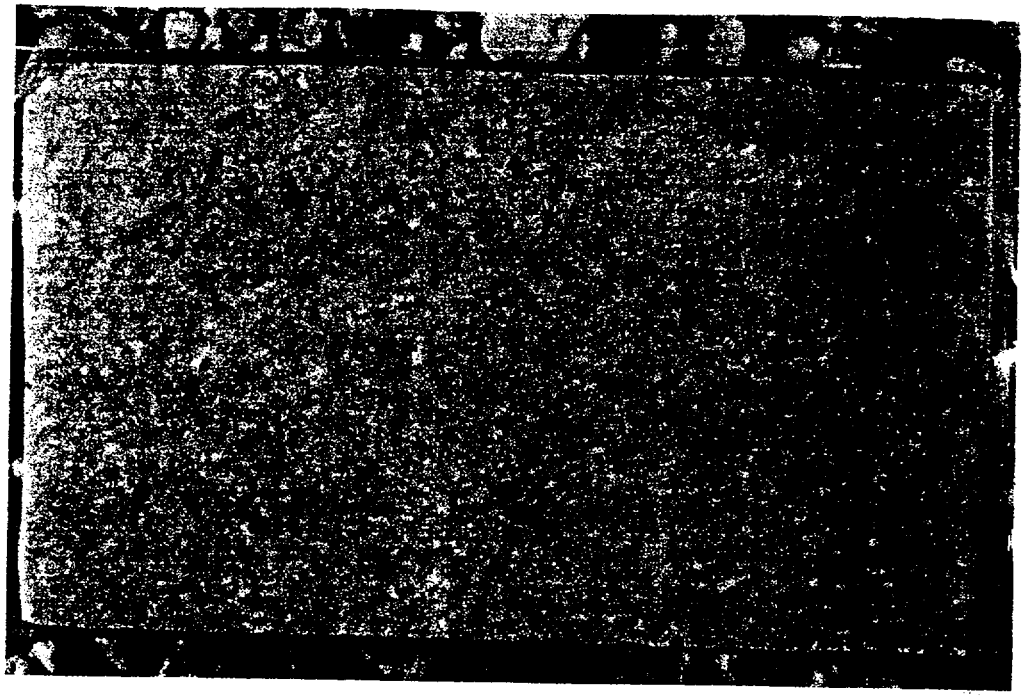
Matrix/Cement (63%) is dominated by sparry dolomite + clay + kaolinite.

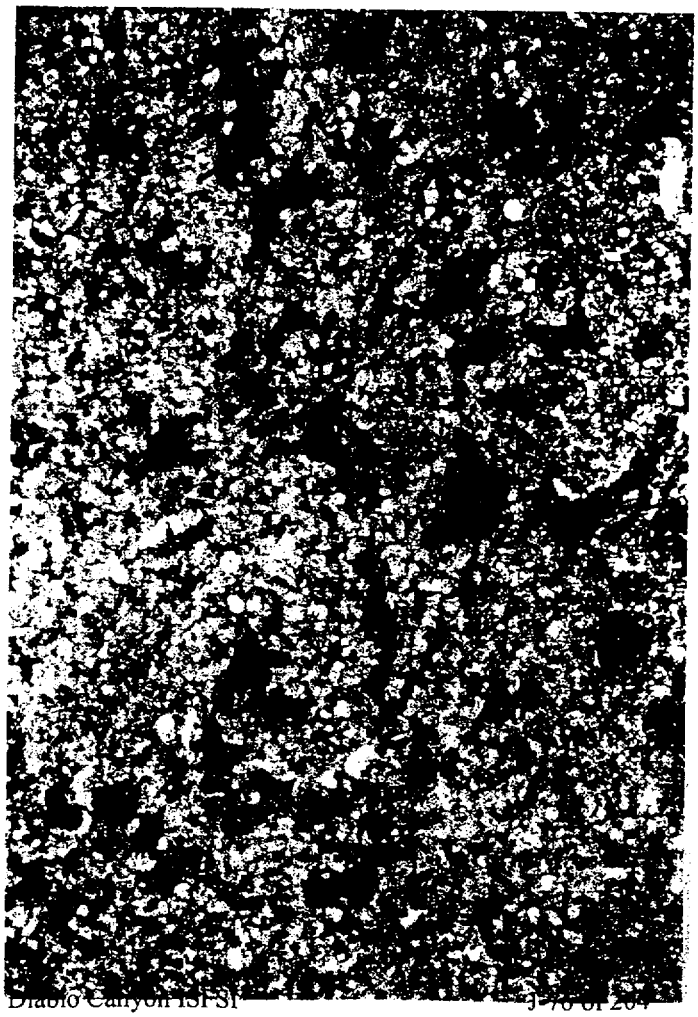
ALTERATION The following alteration features are also present but of indeterminate relative ages: (1) opaques completely altered to FEOH; and (2) glass shards or fish bones completely altered to kaolinite + brown clay.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-14/01013/14/DAY/3X/LBN ALTERED SANDY CARBONATE showing typical appearance of hand specimen.

P-14/01015/16/XPL/28X/LBN ALTERED SANDY CARBONATE showing typical appearance of sponge spicules (O24, E19) and [altered glass shards or fish bones] (N16, Q15, E17) in matrix/cement dominated by sparry dolomite.





P-14

SAMPLE # **P-15** June 27, 2001

ROCK NAME ALTERED SANDY CARBONATE -- probably formed by alteration (secondary dolomite + kaolinite + quartz) of a sandy limestone protolith.

MINERALS Dolomite (45%) + brown clay (20%) + kaolinite (15%) + quartz (10%) + calcite (5%) + opaques (3%) + K-feldspar (2%) + plagioclase (<1%).

TEXTURES Dominantly clastic sedimentary; non-directed fabric.

Detrital Framework Grains (32%) are [angular, 30-80-200 μm quartz (2%) + K-feldspar (2%) + plagioclase (<1%)] + sponge spicules (8%) + altered foraminifera fragments (20%). Contacts between grains are floating.

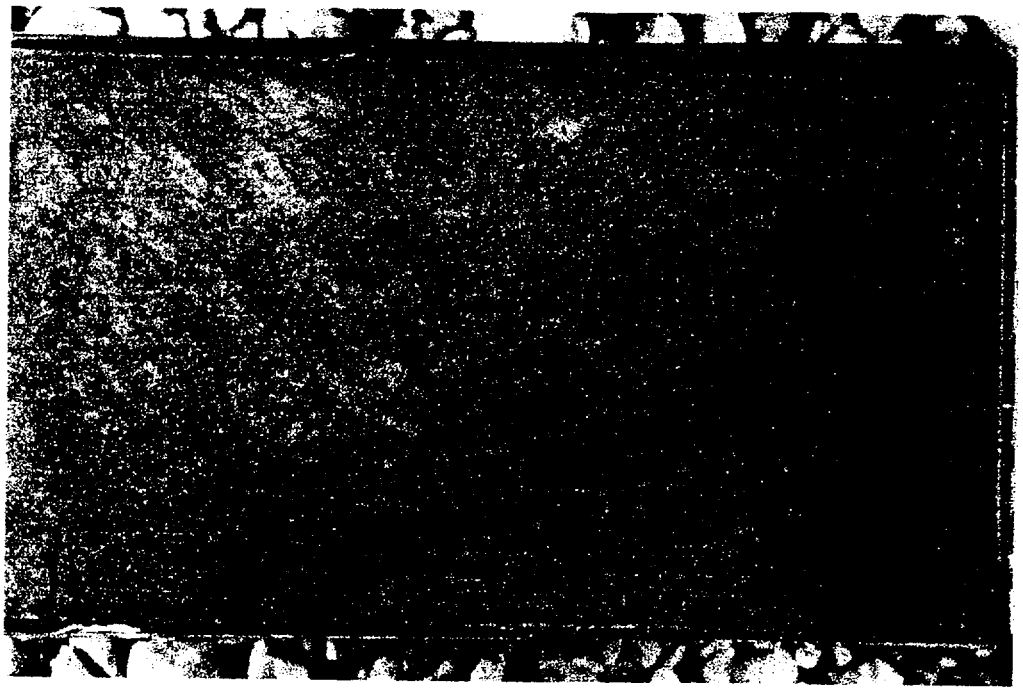
Matrix/Cement (68%) is dominated by subhedral sparry dolomite + clay + kaolinite.

ALTERATION The following alteration features are also present but of indeterminate relative ages: (1) calcite fossil fragments strongly altered to dolomite + kaolinite; and (2) K-feldspar moderately altered to dolomite + quartz.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-15/01013/15/DAY/3X/LBN ALTERED SANDY CARBONATE showing typical appearance of hand specimen.

P-15/01015/17/XPL/57X/LBN ALTERED SANDY CARBONATE showing typical appearance of detrital grains in matrix/cement dominated by subhedral sparry dolomite + clay + kaolinite.



P-15

SAMPLE # **P-16** June 27, 2001

ROCK NAME ALTERED CALCAREOUS CLAYSTONE -- probably formed by alteration (secondary dolomite) of a calcareous claystone protolith.

MINERALS Clay (probably smectite + kaolinite) (45%) + dolomite (37%) + quartz (10%) + K-feldspar (5%) + opaques (3%) + plagioclase (<1%).

TEXTURES Dominantly clastic sedimentary; non-directed fabric.

Detrital Framework Grains (15%) are [angular, 10-60-440 μm quartz (5%) + K-feldspar (5%) + plagioclase (<1%)] + sponge spicules (5%) + lithic fragments (<1) of polycrystalline quartz. Contacts between grains are floating.

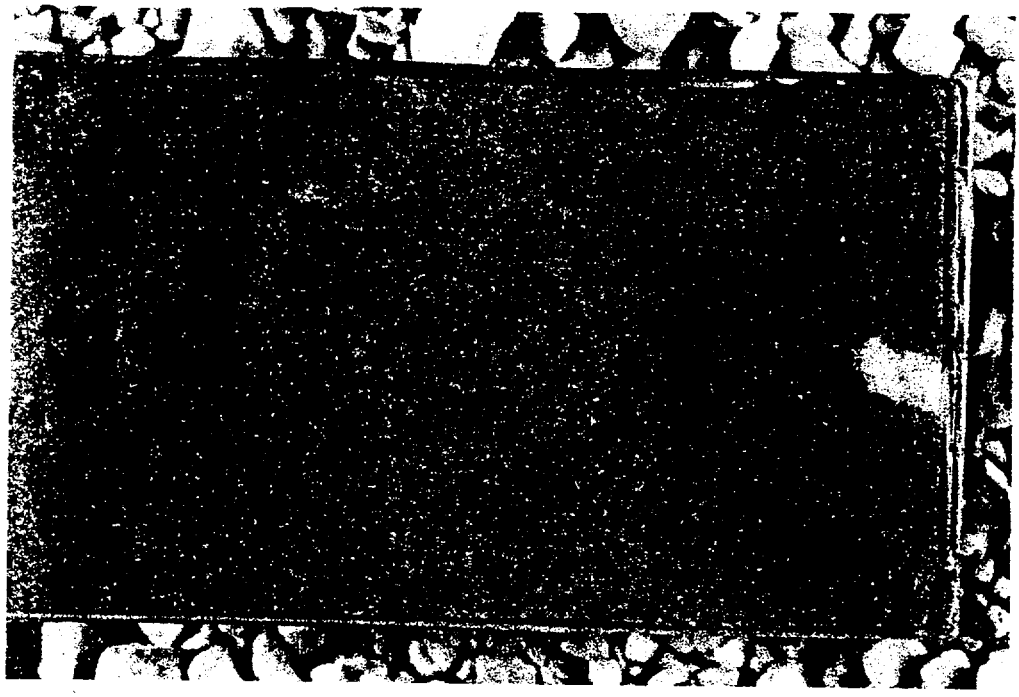
Matrix/Cement (85%) is dominated by clay + subhedral sparry dolomite.

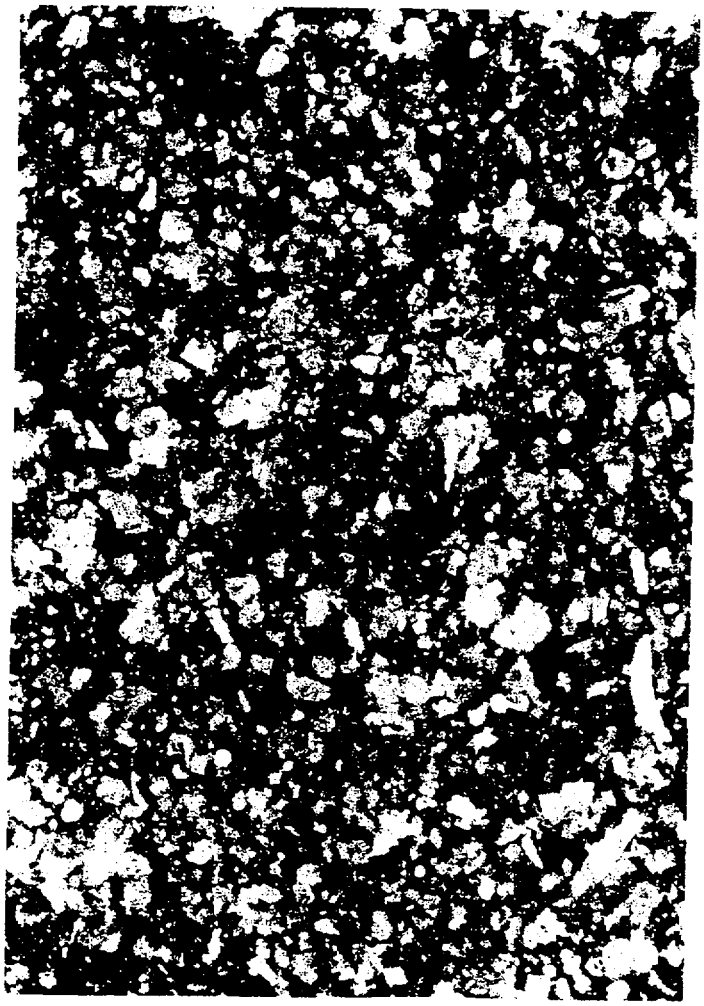
ALTERATION No other alteration features were observed.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-16/01013/16/DAY/3X/LBN ALTERED CALCAREOUS CLAYSTONE showing typical appearance of hand specimen.

P-16/01015/18/XPL/57X/LBN ALTERED CALCAREOUS CLAYSTONE showing typical appearance of detrital grains in matrix/cement dominated by clay + subhedral sparry dolomite.





P-16

SAMPLE # **P-18** June 27, 2001

ROCK NAME ALTERED SANDSTONE -- probably formed by alteration (secondary dolomite + kaolinite + calcite + FEOH) of a medium feldspathic litharenite (McBride, 1963) volcaniclastic protolith.

MINERALS K-feldspar (25%) + dolomite (25%) + kaolinite (15%) + quartz (15%) + brown clay (smectite ?) (10%) + calcite (5%) + FEOH (4%) + plagioclase (1%) + zircon (<1%) + opaques (<1%). Bulk XRD has identified smectite + quartz + dolomite + K-feldspar + kaolinite + calcite + plagioclase + goethite. XRD thus suggests that brown clay is indeed smectite. XRD of oriented clay separates has identified kaolinite + smectite.

TEXTURES Clastic sedimentary; non-directed fabric.

Detrital Framework Grains (61%) are [angular, 120-320-1400 μm, K-feldspar (20%) + quartz (15%) + plagioclase (1%) + zircon (<1%)] + [lithic fragments (26%) of altered trachyte + polycrystalline quartz + granite]. Contacts between grains are tangential.

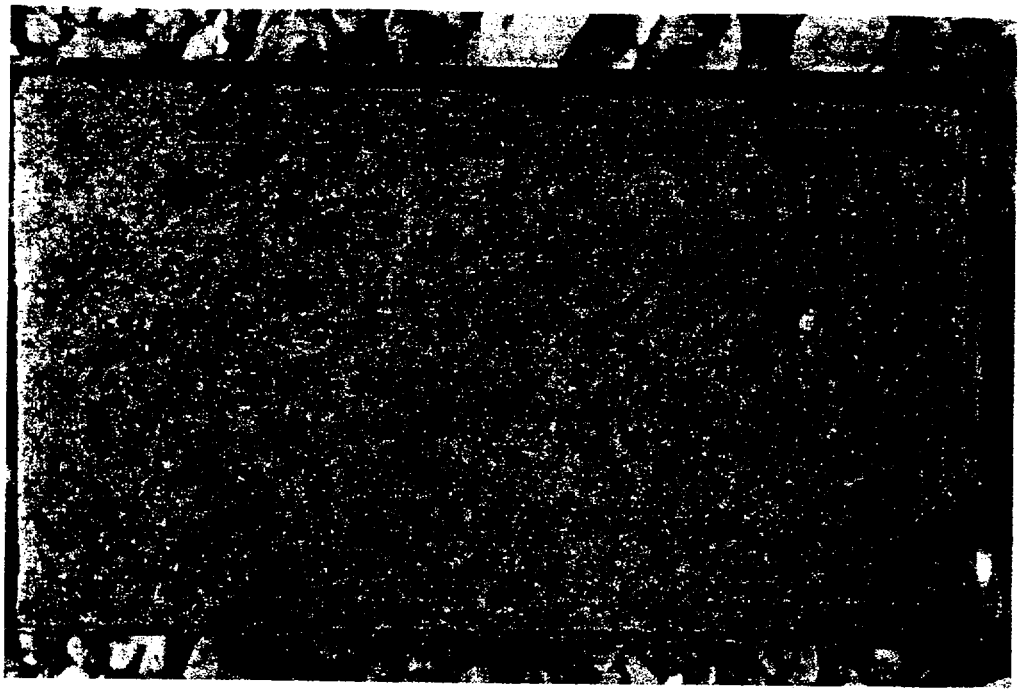
Matrix/Cement (39%) is dominated by dolomite + kaolinite + brown clay.

ALTERATION The following alteration features are present but of indeterminate relative ages: (1) veins or mineralized cataclastic structures of dolomite; (2) K-feldspar moderately altered to calcite + kaolinite; (3) trachyte lithic fragments moderately altered to dolomite + kaolinite; and (3) opaques strongly altered to FEOH.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-18/01013/17/DAY/3X/LBN ALTERED SANDSTONE showing typical appearance of hand specimen.

P-18/01015/19/XPL/28X/LBN ALTERED SANDSTONE showing typical appearance of abundant volcaniclastic detritus dominated by [K-feldspar phenocryst fragments moderately altered to calcite + kaolinite] (Q13) and [lithic fragments of trachyte moderately altered to dolomite + kaolinite] (H11).



P-18

SAMPLE # **P-19** June 27, 2001

ROCK NAME ALTERED CALCAREOUS CLAYSTONE -- probably formed by alteration (secondary dolomite + FEOH + barite) and deformation of a calcareous claystone protolith.

MINERALS Clay (probably smectite + kaolinite) (45%) + dolomite (42%) + K-feldspar (5%) + quartz (3%) + FEOH (3%) + barite (2%) + plagioclase (<1%). Bulk XRD has identified smectite + dolomite + quartz + kaolinite + goethite + K-feldspar + plagioclase. XRD of oriented clay separates has identified smectite + kaolinite. XRD suggests that undifferentiated clay is indeed smectite + kaolinite.

TEXTURES Cataclastically deformed clastic sedimentary; non-directed fabric.

Detrital Framework Grains (8%) are [angular, 40-120-520 μm quartz (3%) + K-feldspar (5%) + plagioclase (<1%)] + lithic fragments (<1%) of granite. Contacts between grains are floating.

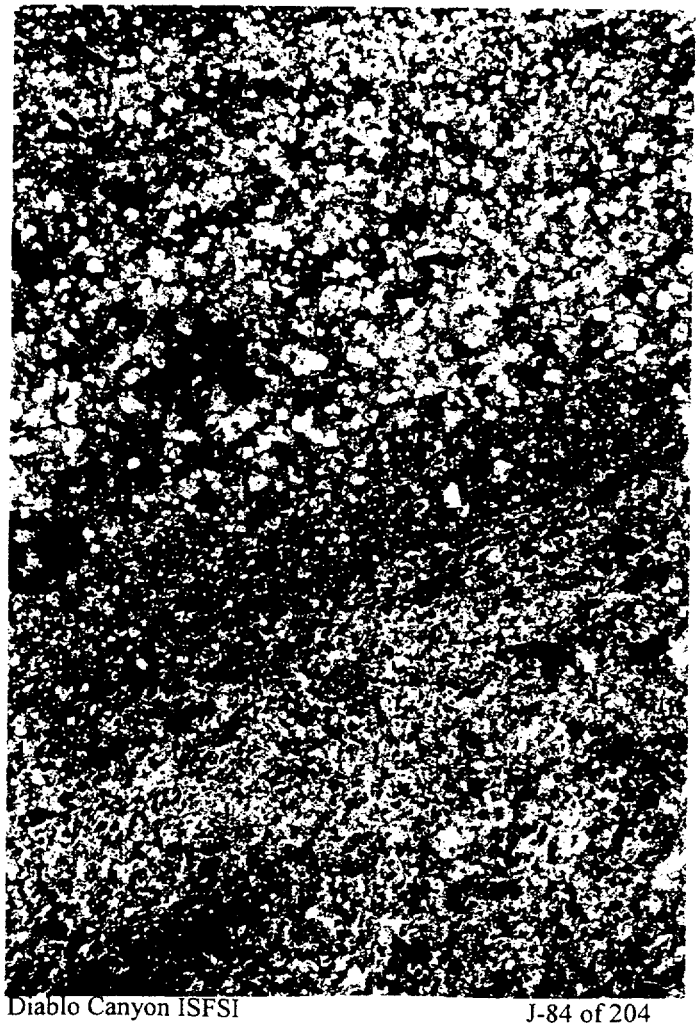
Matrix/Cement (92%) is dominated by clay + euhedral sparry dolomite.

ALTERATION The following alteration features are also present but of indeterminate relative ages: (1) cataclastic deformation; and (2) opaques completely altered to FEOH.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-19/01013/18/DAY/3X/LBN ALTERED CALCAREOUS CLAYSTONE showing typical appearance of deformation in hand specimen.

P-19/01015/20/XPL/28X/LBN ALTERED CALCAREOUS CLAYSTONE showing typical appearance of cataclastic deformation.



P-19

SAMPLE # **P-20** June 27, 2001

ROCK NAME ALTERED SANDSTONE -- probably formed by alteration (secondary dolomite + kaolinite + calcite + FEOH) of a medium feldspathic litharenite (McBride, 1963) volcaniclastic protolith.

MINERALS Clay (probably smectite + kaolinite) (61%) + dolomite (20%) + quartz (7%) + K-feldspar (6%)+ plagioclase (3%) + opaques (3%). Bulk XRD has identified smectite + dolomite + quartz + plagioclase + pyrite. XRD suggests that undifferentiated clay is dominantly smectite.

TEXTURES Clastic sedimentary; non-directed fabric.

Detrital Framework Grains (16%) are [angular, 40-320-1840 μm quartz (7%) + K-feldspar (3%) + plagioclase (3%)] + sponge spicules (<1%) + lithic fragments (3%) of altered trachyte + metamorphic rock + abundant (?) altered glass shards. Contacts between grains are floating to tangential.

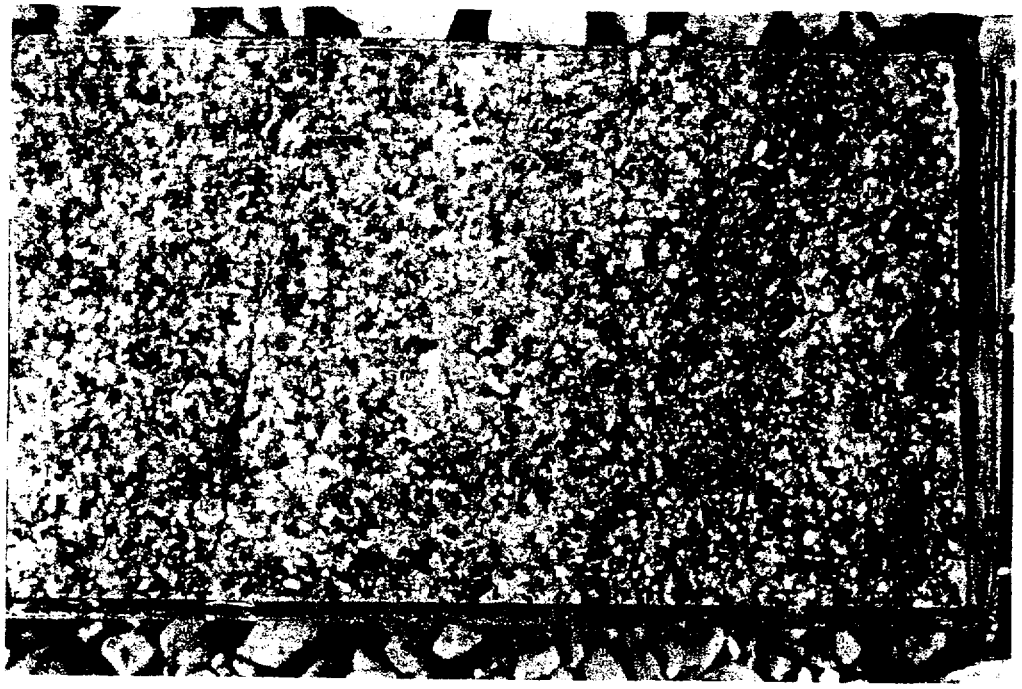
Matrix/Cement (84%) is dominated by clay + euhedral sparry dolomite.

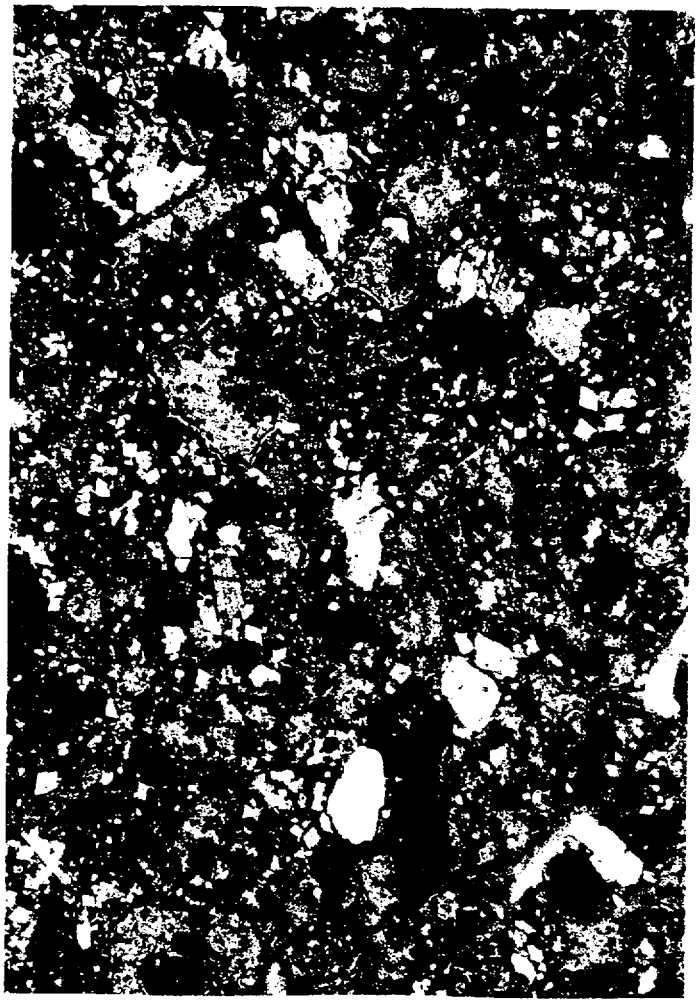
ALTERATION The following alteration features are also present but of indeterminate relative ages: (1) volcanic glass (?) completely altered to clay + dolomite.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-20/01013/19/DAY/3X/LBN ALTERED SANDSTONE showing typical appearance of hand specimen.

P-20/01015/21/XPL/28X/LBN ALTERED SANDSTONE showing typical appearance of abundant volcaniclastic detritus.





P-20

SAMPLE # **P-21** June 27, 2001

ROCK NAME ALTERED CLAYEY CARBONATE -- probably formed by alteration (secondary dolomite) of a clayey fossiliferous limestone protolith.

MINERALS Dolomite (71%) + clay (probably kaolinite + smectite) (15%) + quartz (10%) + K-feldspar (4%) + plagioclase (<1%). Bulk XRD has identified dolomite + smectite + quartz + kaolinite. XRD suggests that undifferentiated clay is indeed kaolinite + smectite.

TEXTURES Dominantly clastic sedimentary; non-directed fabric.

Detrital Framework Grains (14%) are [angular, 40-160-1200 μm, quartz (1%) + K-feldspar (<1%) + plagioclase (<1%)] + lithic fragments (4%) of altered trachyte. Contacts between grains are floating.

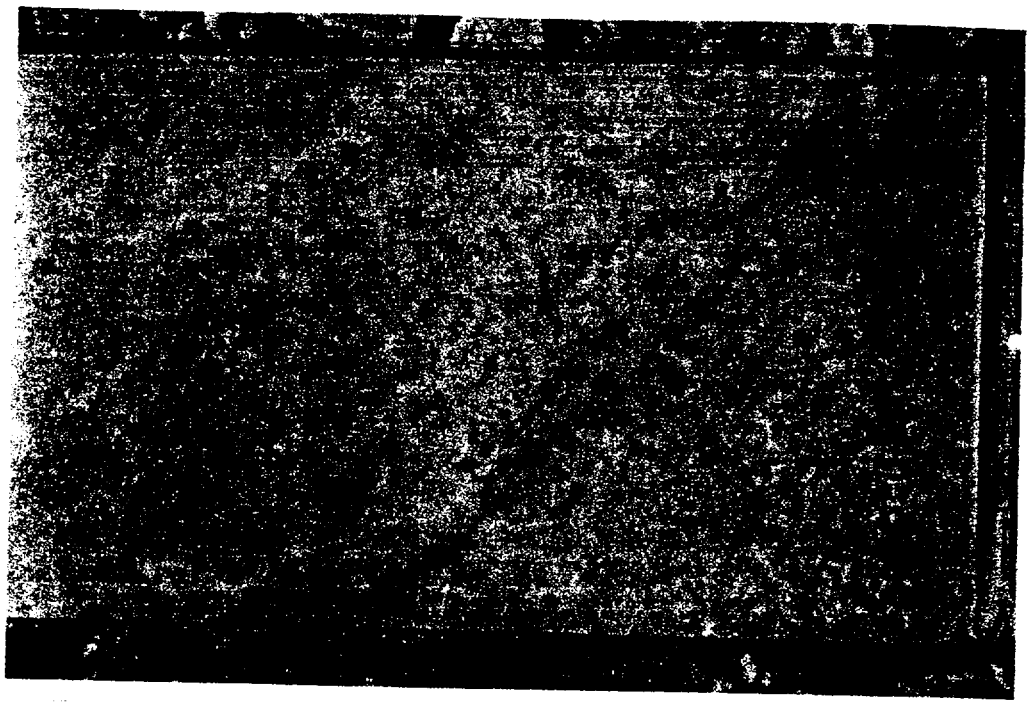
Matrix/Cement (86%) is composed of euhedral sparry dolomite + clay.

ALTERATION No other alteration features were observed.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-21/01013/20/DAY/3X/LBN ALTERED CLAYEY CARBONATE showing typical appearance of hand specimen.

P-21/01015/22/XPL/57X/LBN ALTERED CLAYEY CARBONATE showing typical appearance of sponge spicules (K10, P13, Q20) in matrix/cement dominated by sparry euhedral dolomite.



P-21

SAMPLE # **P-22** June 27, 2001

ROCK NAME ALTERED CALCAREOUS CLAYSTONE -- probably formed by alteration (secondary kaolinite + dolomite + FEOH) of a calcareous claystone protolith with a significant volcaniclastic component.

MINERALS Clay (probably smectite + kaolinite) (39%) + dolomite (39%) + quartz (10%) + K-feldspar (8%)+ FEOH (4%) + plagioclase (<1%). Bulk XRD has identified dolomite + smectite + quartz + K-feldspar + kaolinite + goethite + plagioclase. XRD suggests that undifferentiated clay is indeed smectite + kaolinite.

TEXTURES Clastic sedimentary; non-directed fabric.

Detrital Framework Grains (18%) are [angular, 40-160-520 μm quartz (10%) + K-feldspar (3%) + plagioclase (<1%)] + sponge spicules (<1%) + lithic fragments (5%) of altered trachyte + granite. Contacts between grains are floating.

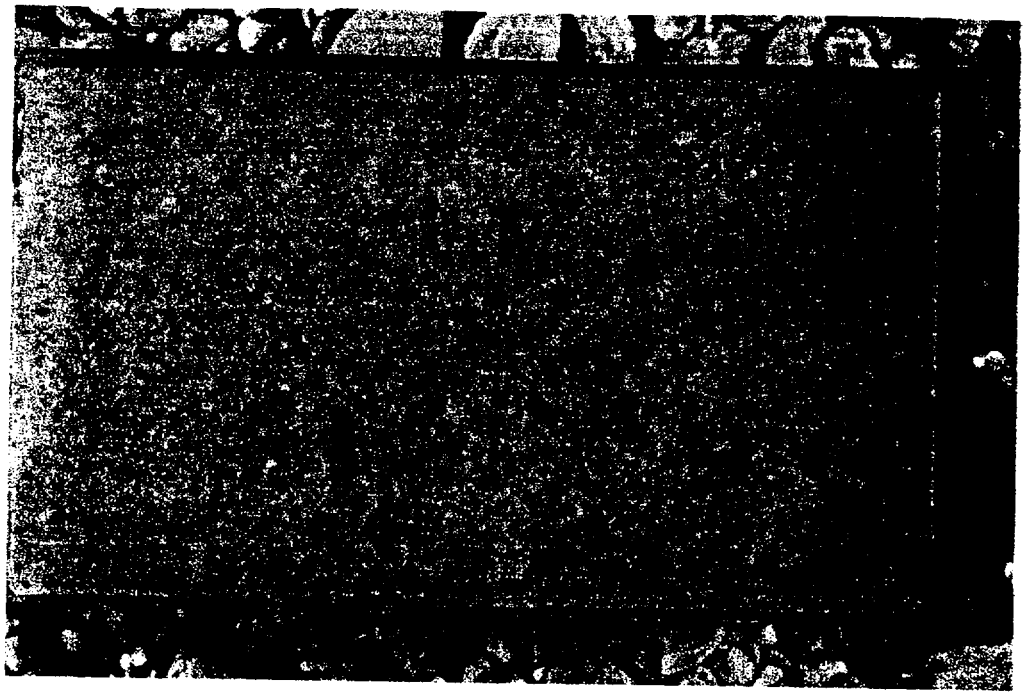
Matrix/Cement (82%) is dominated by clay + subhedral sparry dolomite.

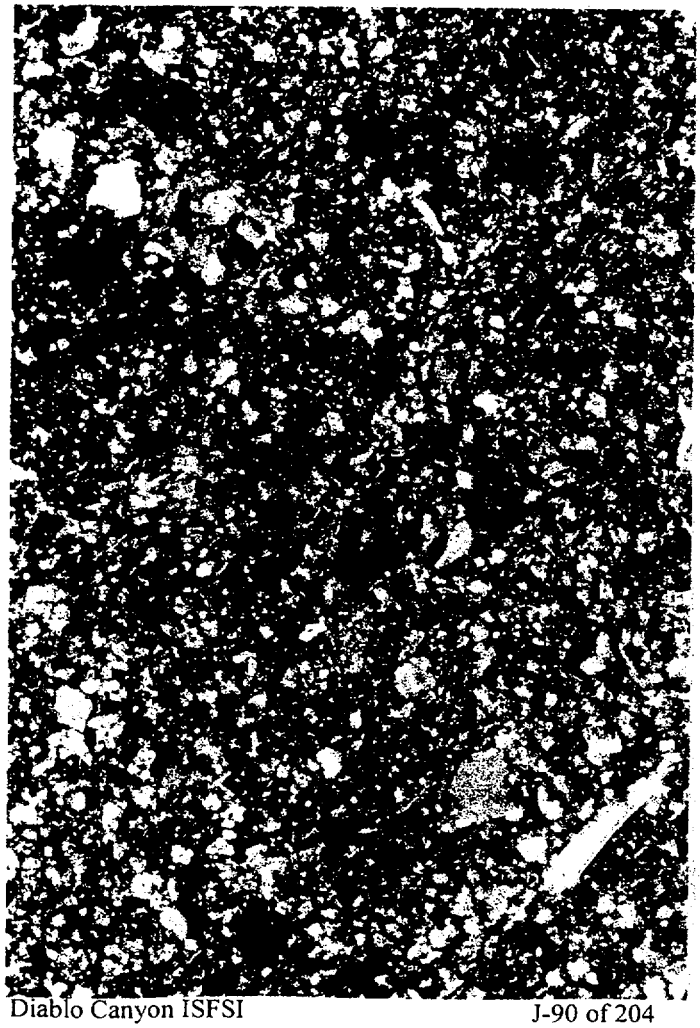
ALTERATION The following alteration features are also present but of indeterminate relative ages: (1) K-feldspar weakly altered to dolomite + kaolinite; and (2) opaques completely altered to FEOH.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-22/01013/21/DAY/3X/LBN ALTERED CALCAREOUS CLAYSTONE showing typical appearance of hand specimen.

P-22/01015/23/XPL/57X/LBN ALTERED CALCAREOUS CLAYSTONE showing typical appearance of detrital grains in matrix/cement of subhedral sparry dolomite.





P-22

SAMPLE # **P-23** June 27, 2001

ROCK NAME ALTERED CLAYEY CARBONATE -- probably formed by alteration (secondary dolomite + FEOH) of a clayey fossiliferous limestone protolith.

MINERALS Dolomite (65%) + clay (probably smectite + kaolinite) (15%) + calcite (10%) + quartz (5%) + FEOH (3%) + K-feldspar (1%) + opaques (1%) + plagioclase (<1%). Bulk XRD has identified quartz + calcite + dolomite + K-feldspar + plagioclase + smectite + kaolinite + goethite + substantial amorphous material. XRD suggests that undifferentiated clay and probably most amorphous material is indeed smectite + kaolinite.

TEXTURES Dominantly clastic sedimentary; non-directed fabric.

Detrital Framework Grains (16%) are [angular, 10-60-160 μm, quartz (4%) + K-feldspar (1%) + plagioclase (<1%)] + sponge spicules (1%)+ calcitic microfossils (foraminifera ?) (10%). Contacts between grains are floating.

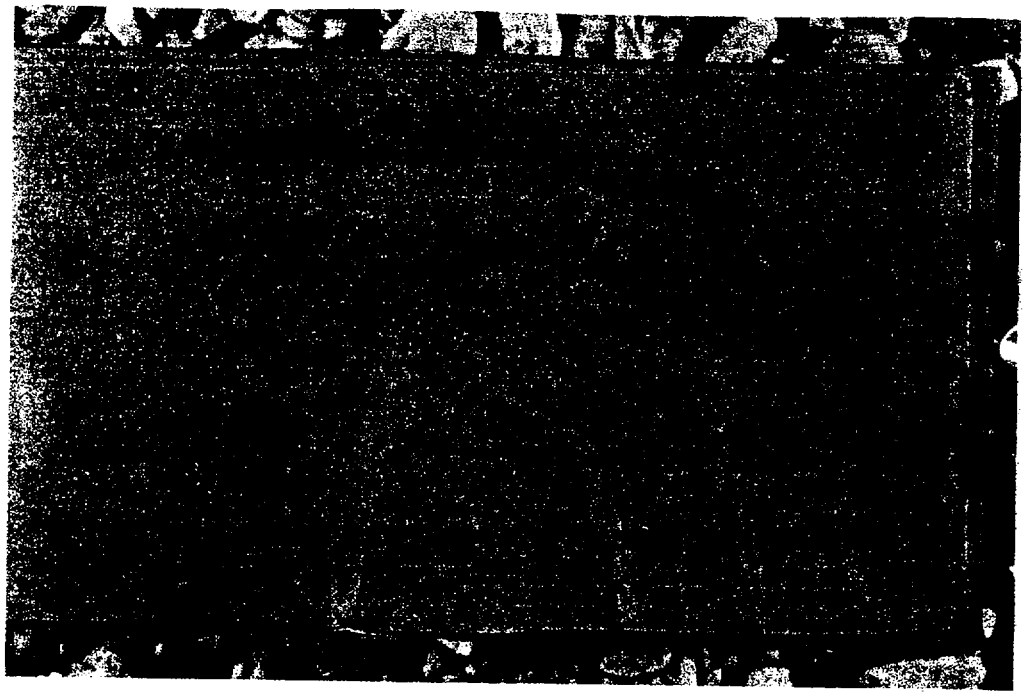
Matrix/Cement (84%) is composed of fine granoblastic dolomite + clay.

ALTERATION The following alteration features are also present but of indeterminate relative ages: (1) calcite strongly altered to dolomite; and (2) opaques strongly altered to FEOH.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN + ARS + PF Cover: PLA

PHOTOS P-23/01013/22/XPL/3X/LBN ALTERED CLAYEY CARBONATE showing typical appearance of hand specimen.

P-23/01015/24/XPL/57X/LBN ALTERED CLAYEY CARBONATE showing typical appearance of sponge spicules (H22) and forams (?) (I9, K11) in matrix/cement of granoblastic dolomite.



P-23

DATA REPORT J

ATTACHMENT 3

SPECTRUM PETROGRAPHICS, INC., X-RAY DIFFRACTION ANALYSIS DATA OF ROCK SAMPLES AT THE DCPP ISFSI SITE

DIABLO CANYON ISFSI

Spectrum Petrographics- M. DePangher

William Lettis & Assoc.
Diablo Canyon ISFSI
Site-
core samples

Mineralogy, Approx. Wt.% [X] (or) Relative Abundance [ ]

Sample No.	Quartz	Plagioclase	K-feldspar	Calcite	Dolomite	Ferroan Dolomite	Carbonate Apatite	Pyrite	Goethite	Kaolin	Smectite	Mixed-layer illite-smectite	Amorphous/ Below detection	
P-6 Bulk	24	4	15		11			1?	tr	10	30		5	
P-9 Bulk	20	2	7	10	17		^3?		tr	3	13		^25	^ poorly crystalline carbonates + apatite?
P-10 Bulk	21	4	9	1	15			3		6	27		14	
P-11 Bulk	31	1	7		42				tr	3	1		15	
P-18 Bulk	16	3	9	4	15				2	9	42		-	
Clay										*75	24	1		*very fine-grained
P-19 Bulk	20	2	3		35				4	4	32		-	
Clay										16	84			dioctahedral smectite
P-20 Bulk	14	6	4		15			4		tr	57		-	
P-21 Bulk	7				78					1	14		-	
P-22 Bulk	20	2	6		33				3	5	31		-	
P-23 Bulk	16	2	5	20	8	19			tr	tr	2		^28	

Amorphous content may consist of iron oxides-hydroxides, opaline silica, and/or carbonates or clays that are not as crystalline as the standards used for quantification.

MM = Predominant M = Major m = Minor Tr = Trace ? = Tentative Identification

EGI

SUMMARY OF X-RAY DIFFRACTION ANALYSIS
Energy & Geoscience Institute at the University of Utah

S. Lutz
6-01
(revised 1)
801 585-9088

Spectrum Petrographics- M. DePangher

William Lettis & Assoc.
Diablo Canyon ISFSI
Site-
core samples

Mineralogy, Approx. Wt.% [X] (or) Relative Abundance [ ]

Sample No.	Quartz	Plagioclase	K-feldspar	Calcite	Dolomite	Ferroan Dolomite	Carbonate Apatite	Pyrite	Goethite	Kaolin	Smectite	Mixed-layer illite-smectite	Amorphous/ Below detection					
P-6 Bulk	24	4	15			11			1?	tr		10	30			5		
P-9 Bulk	20	2	7		10	17		^3?		tr		3	13			^25		^ poorly crystalline carbonates + apatite?
P-10 Bulk	21	4	9		1	15			3			6	27			14		
P-11 Bulk	31	1	7			42				tr		3	1			15		
P-18 Bulk	16	3	9		4	15				2		9	42			-		
Clay												*75	24	1				*very fine-grained
P-19 Bulk	20	2	3			35				4		4	32			-		
Clay												16	84					dioctahedral smectite
P-20 Bulk	14	6	4			15			4			tr	57			-		
P-21 Bulk	7					78						1	14			-		
P-22 Bulk	20	2	6			33				3		5	31			-		
P-23 Bulk	16	2	5		20	8	19			tr		tr	2			^28		

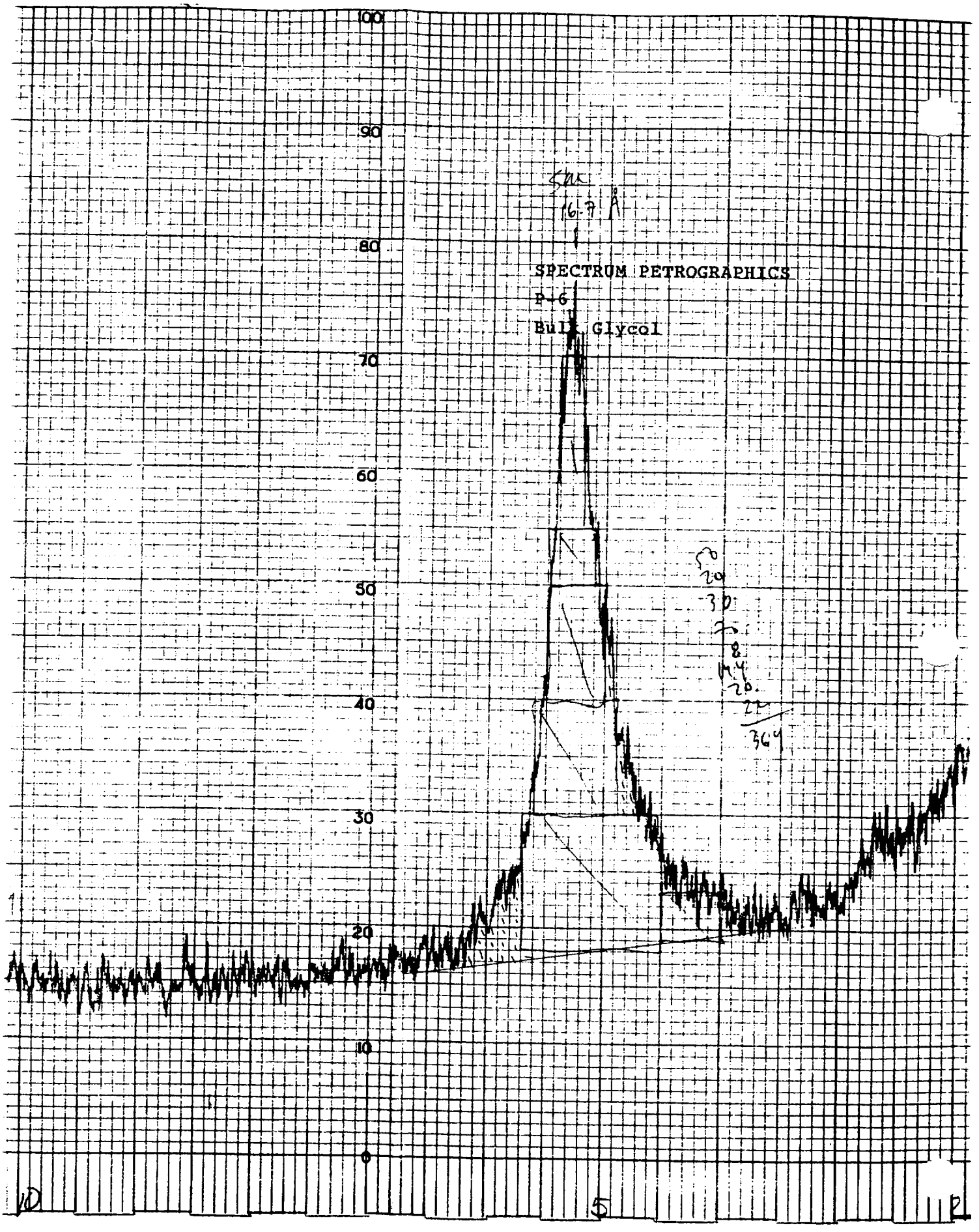
Amorphous content may consist of iron oxides-hydroxides, opaline silica, and/or carbonates or clays that are not as crystalline as the standards used for quantification.

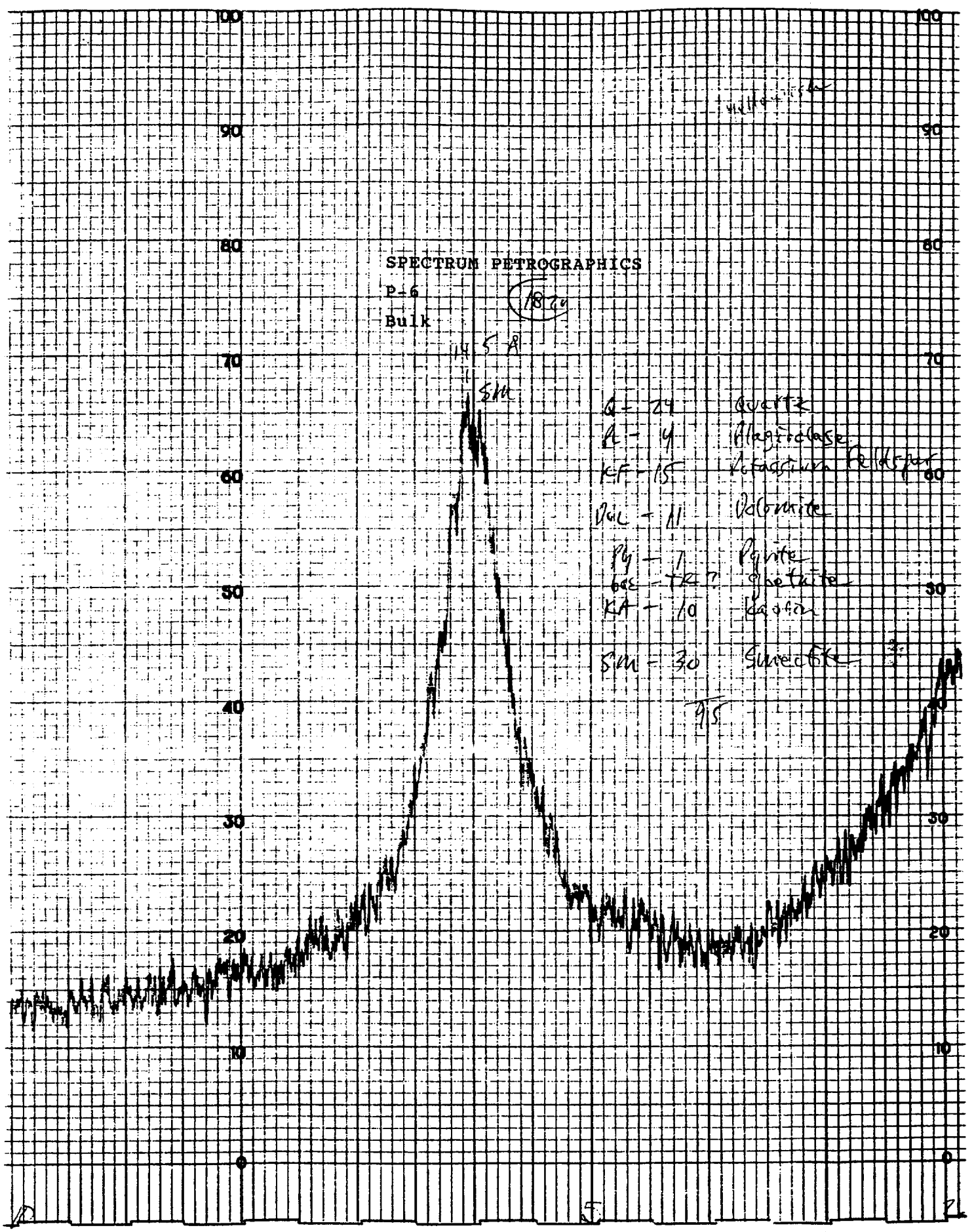
MM = Predominant M = Major m = Minor Tr = Trace ? = Tentative Identification

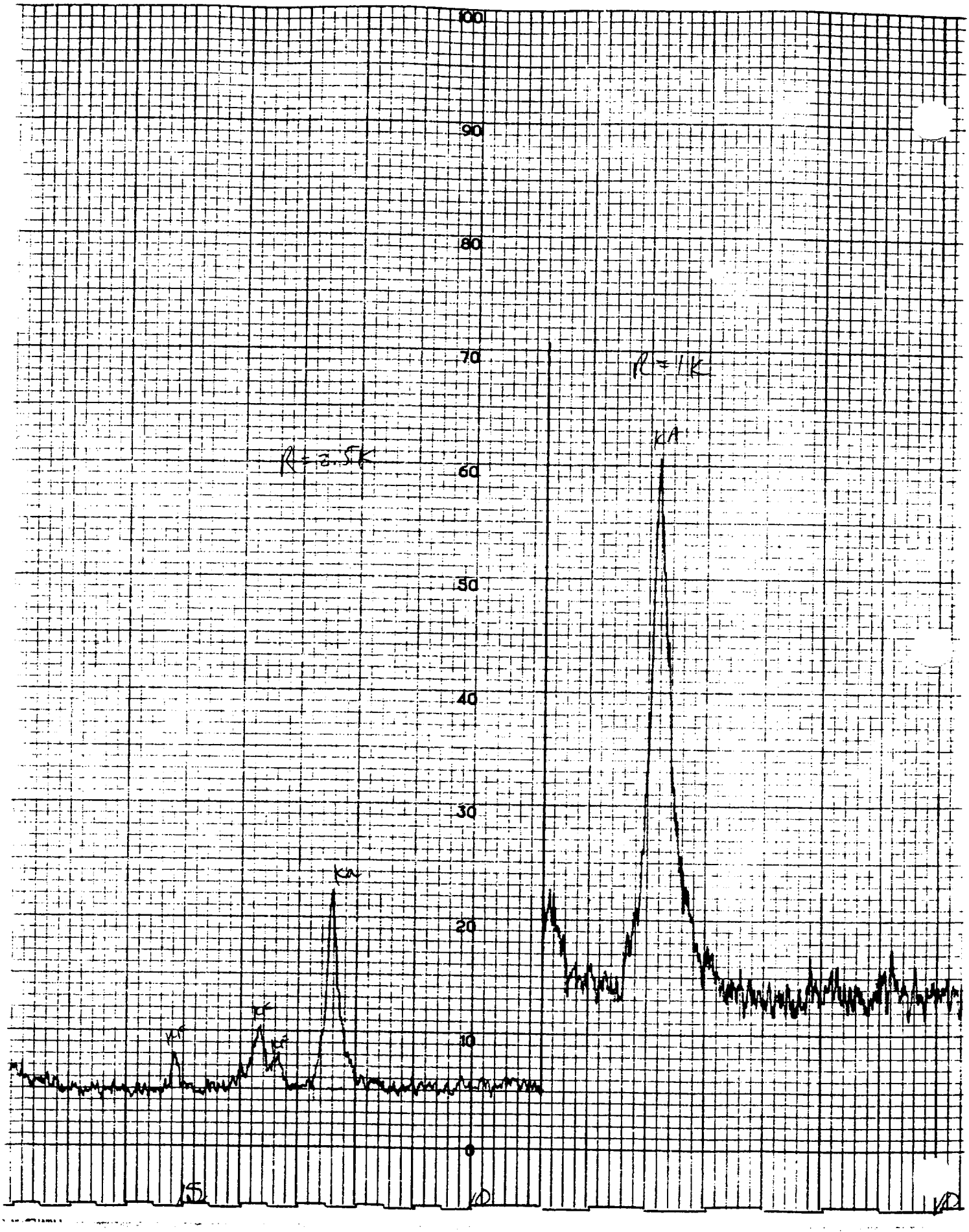
EGI

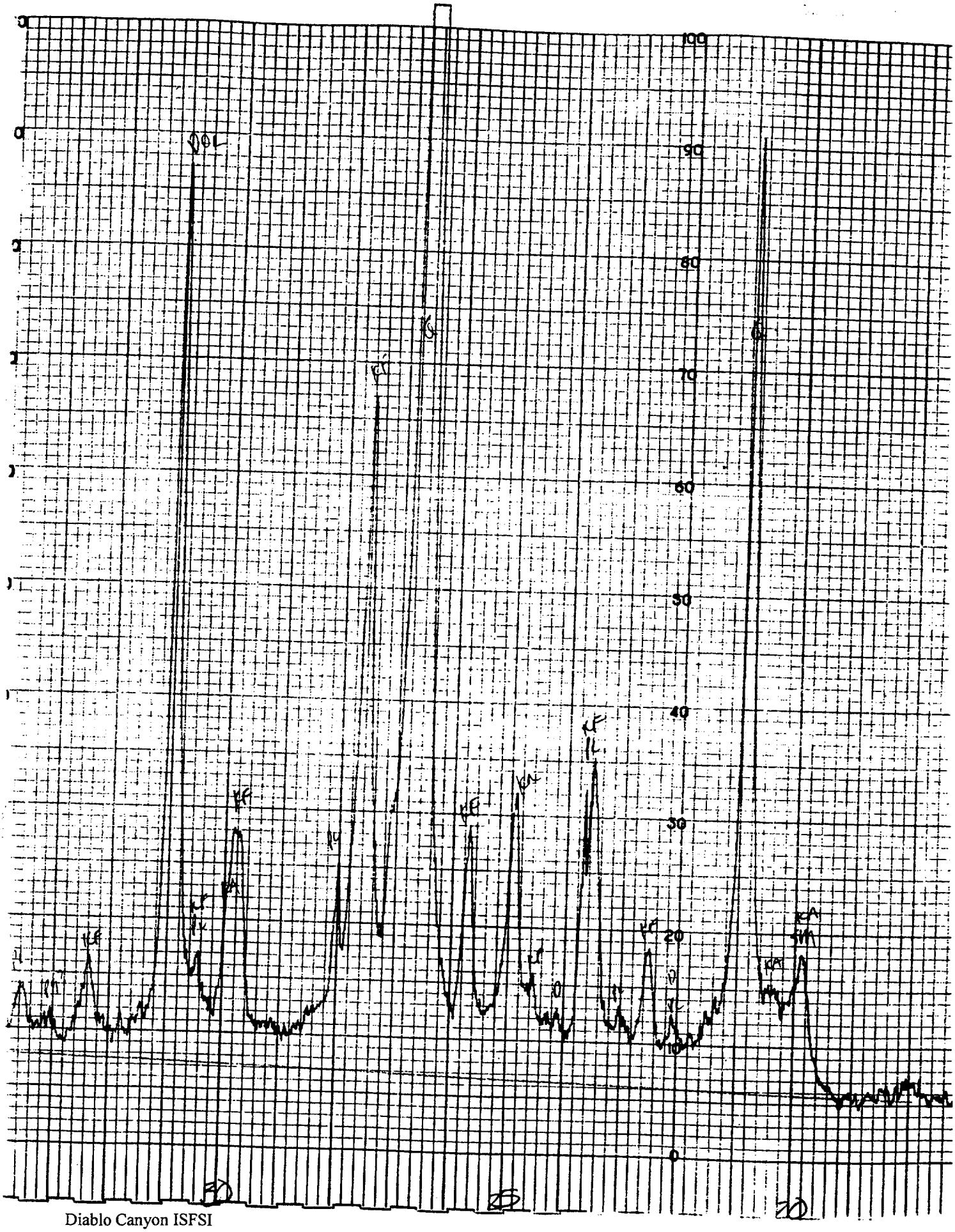
SUMMARY OF X-RAY DIFFRACTION ANALYSIS
Energy & Geoscience Institute at the University of Utah

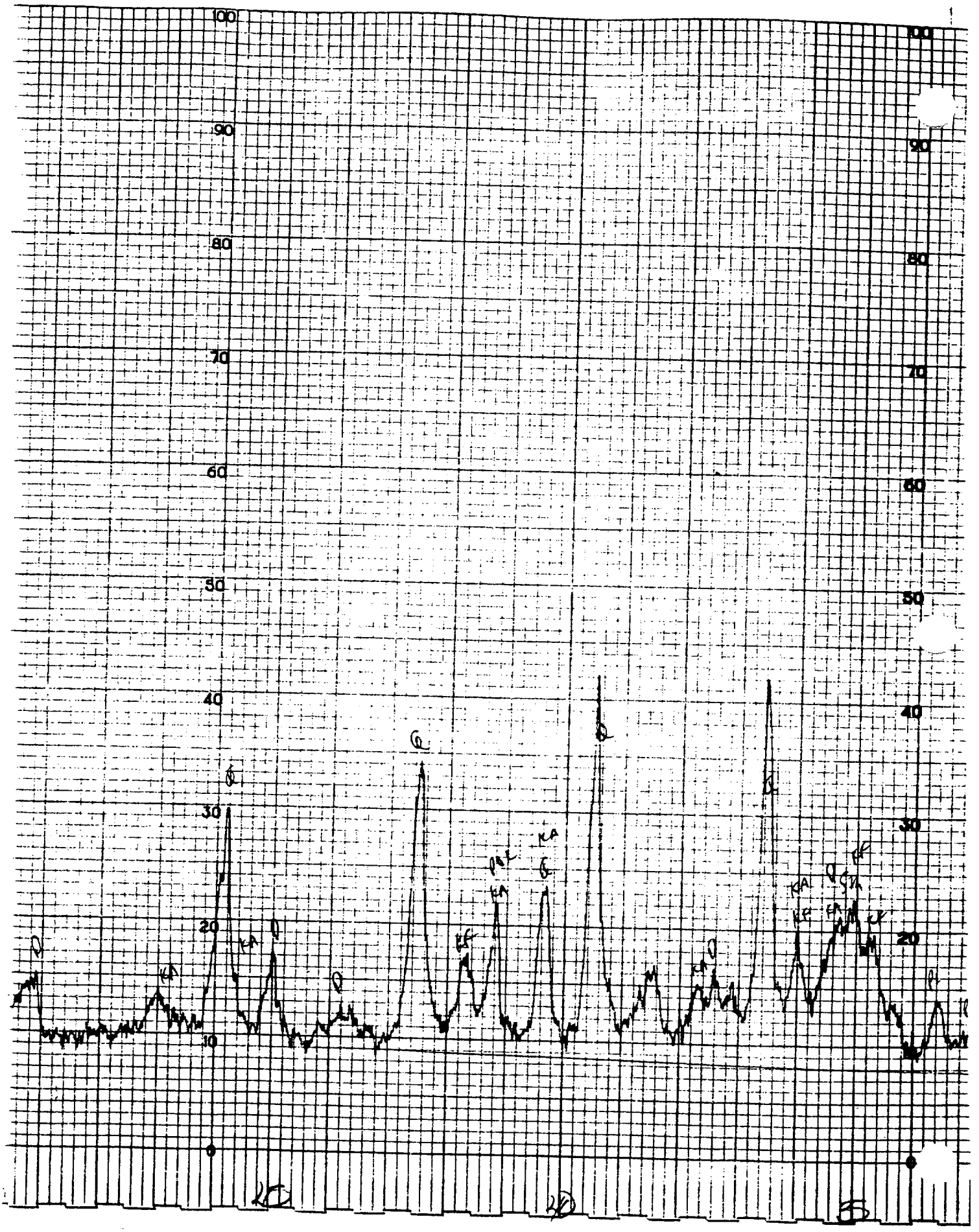
S. Lutz
6-01
(revised 8-01)
801 585-9688

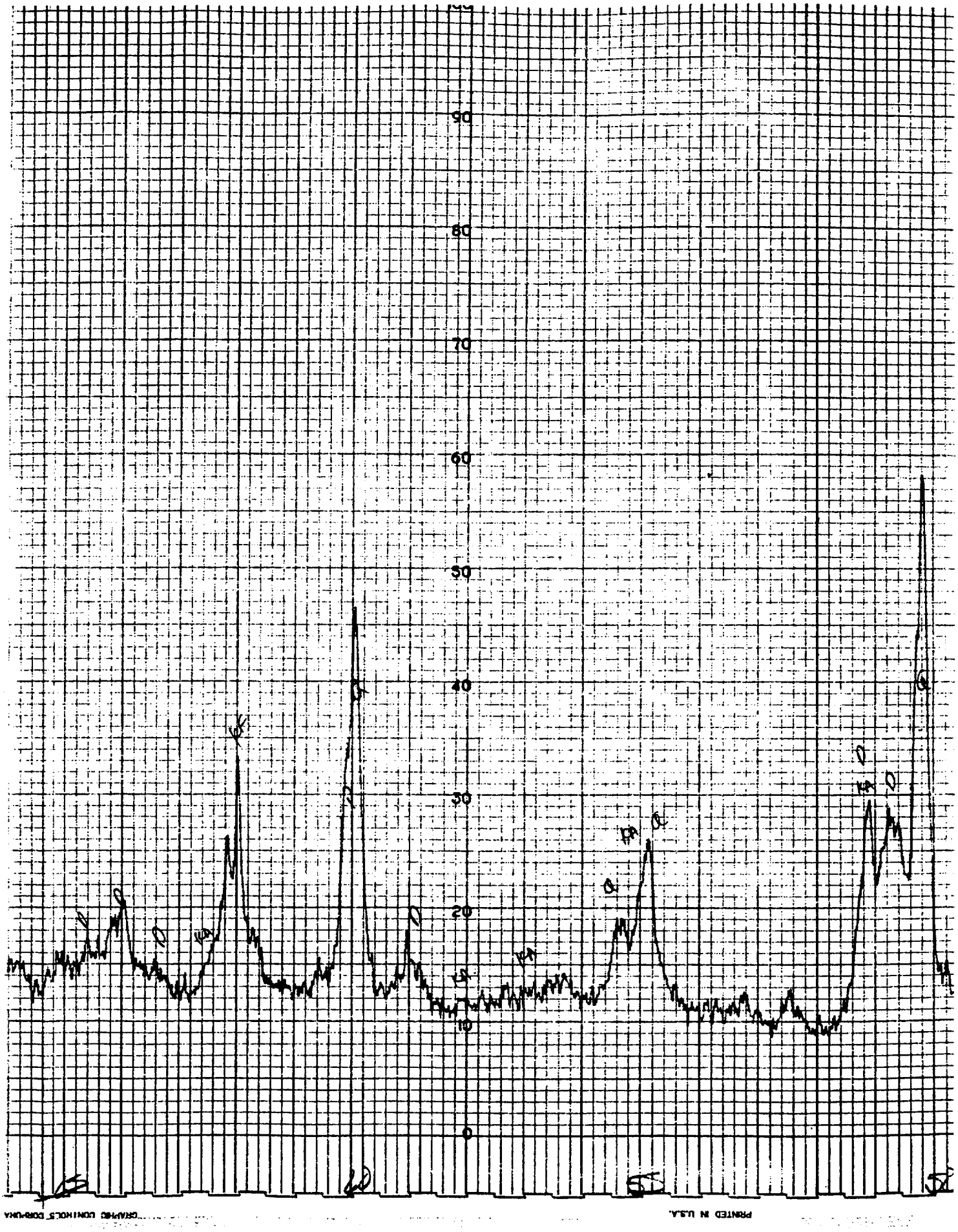

100
90
80
70
60
50
40
30
20
10
0
SPECTRUM PETROGRAPHICS
P-6
Bulk Glycol

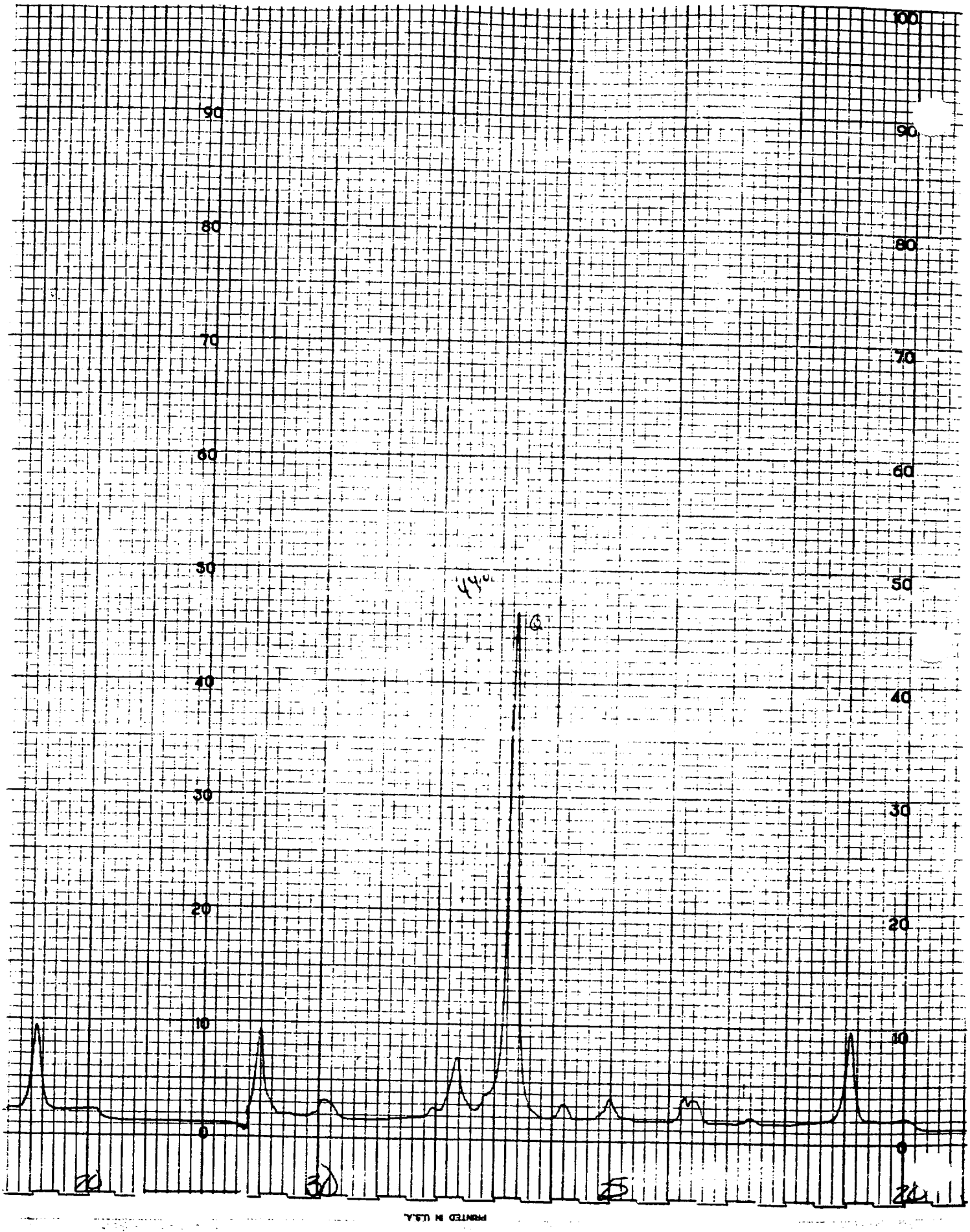

SPECTRUM PETROGRAPHICS
P-6
Bulk
14.5 Å
SM
Q - 29 Quartz
A - 4 Albite
KF - 15 Potassium Feldspar
DOL - 11 Dolomite
Py - 1 Pyrite
Sph - TR? Sphalerite
KA - 10 Kaolin
SM - 30 Smectite
95
100
90
80
70
60
50
40
30
20
10
0

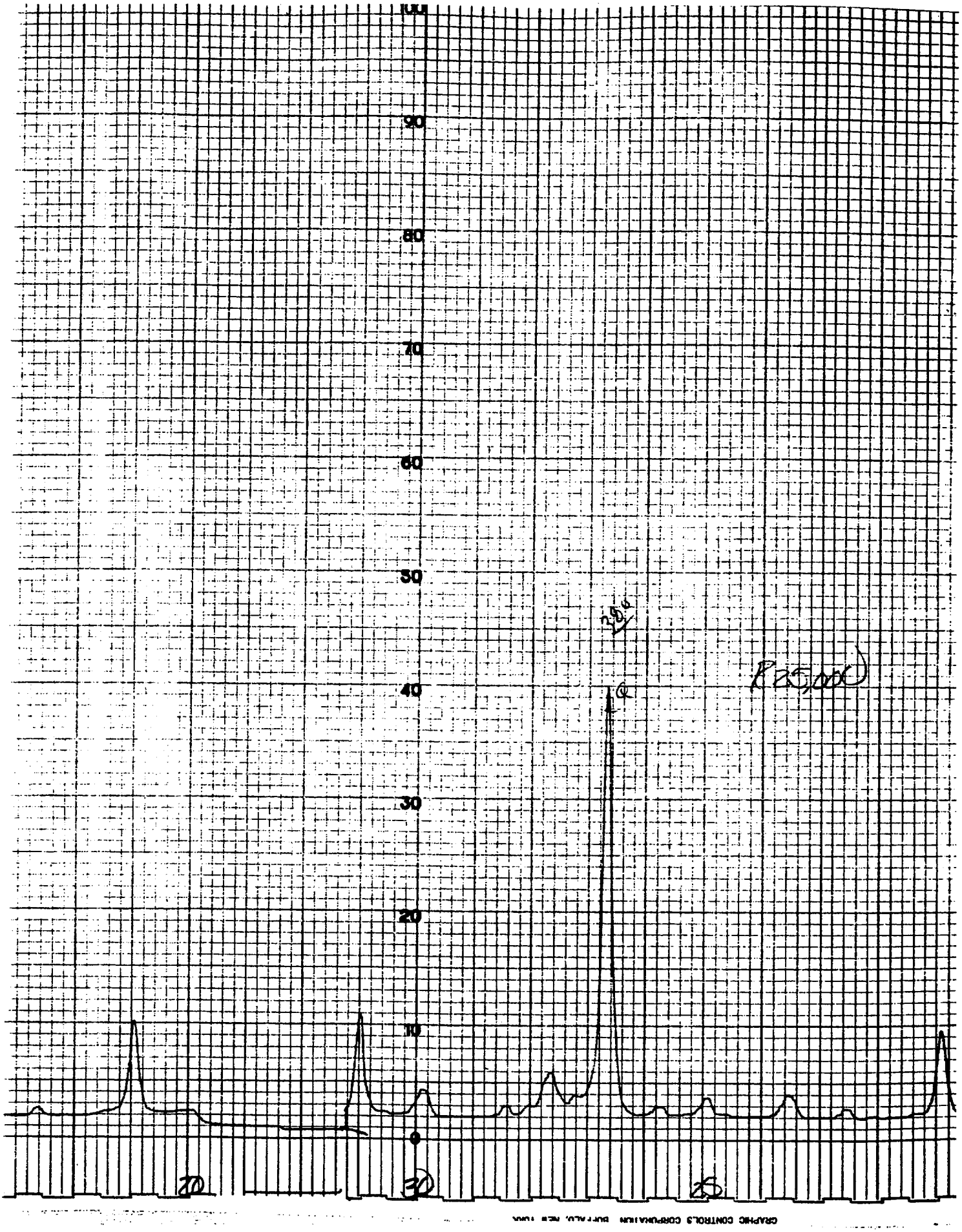

100
90
80
70
60
50
40
30
20
10
0
R=1K
R=2.5K
Kα
Kα
Kα
Kα
Kα

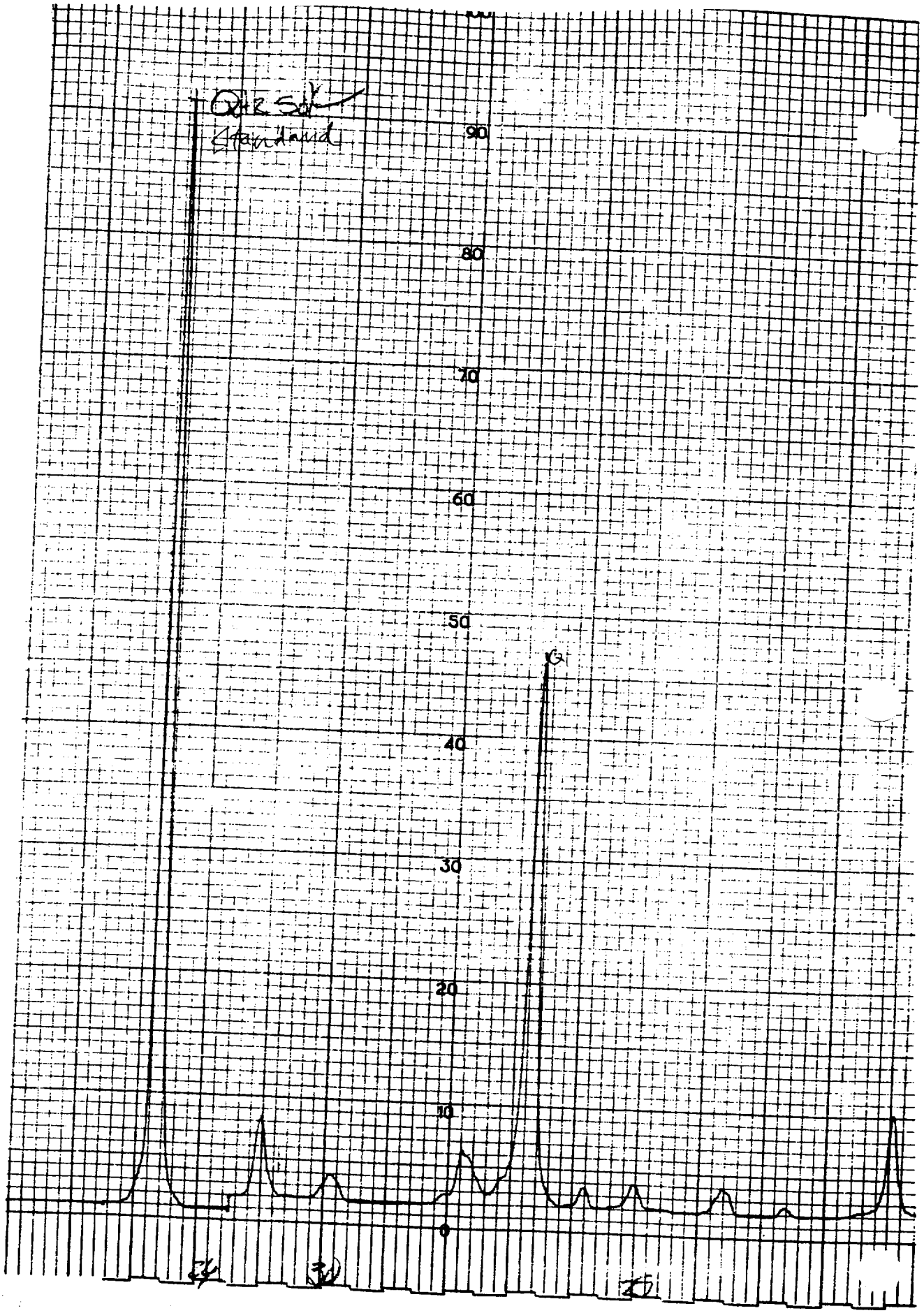

100
90
80
70
60
50
40
30
20
10
0

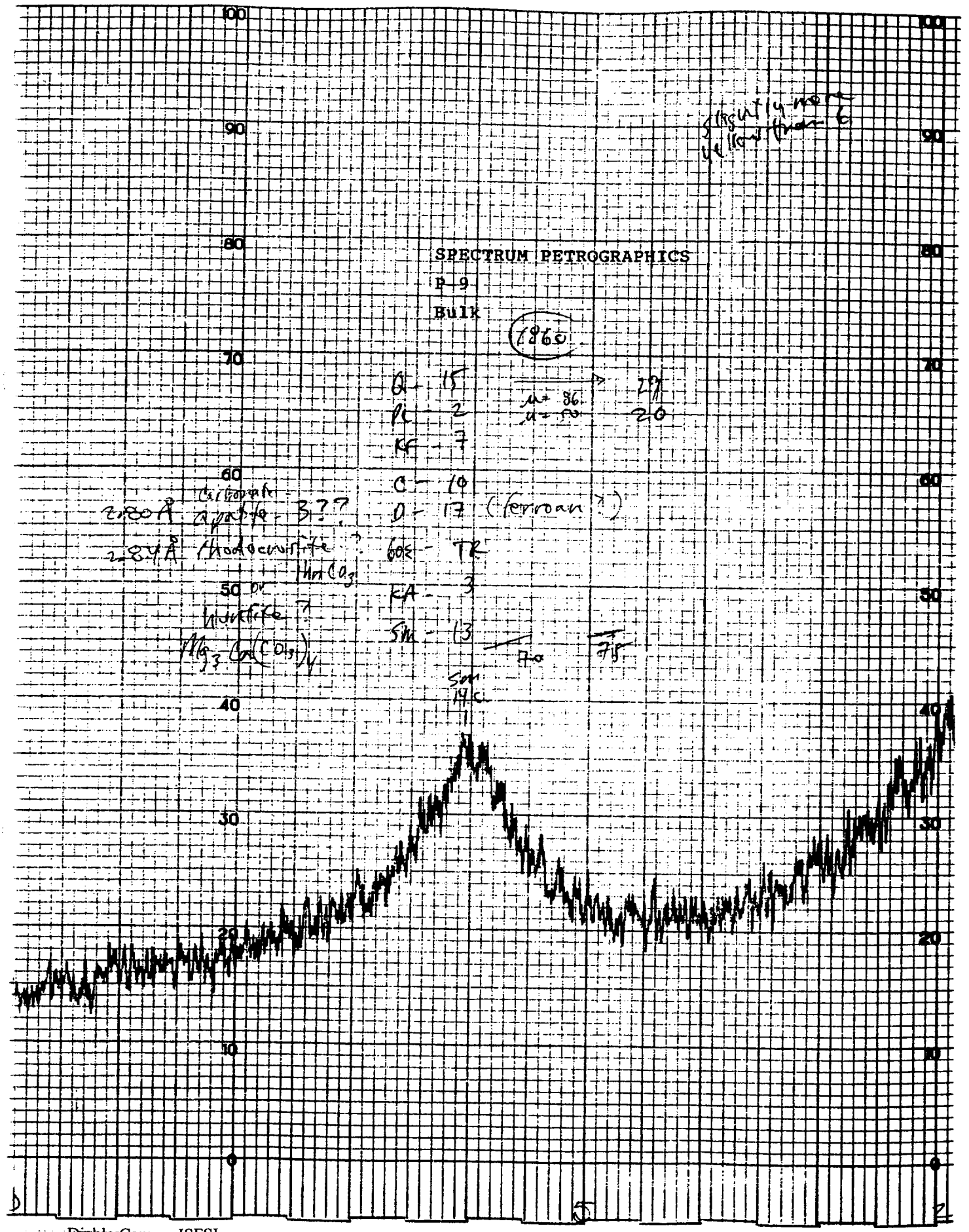

100
90
80
70
60
50
40
30
20
10

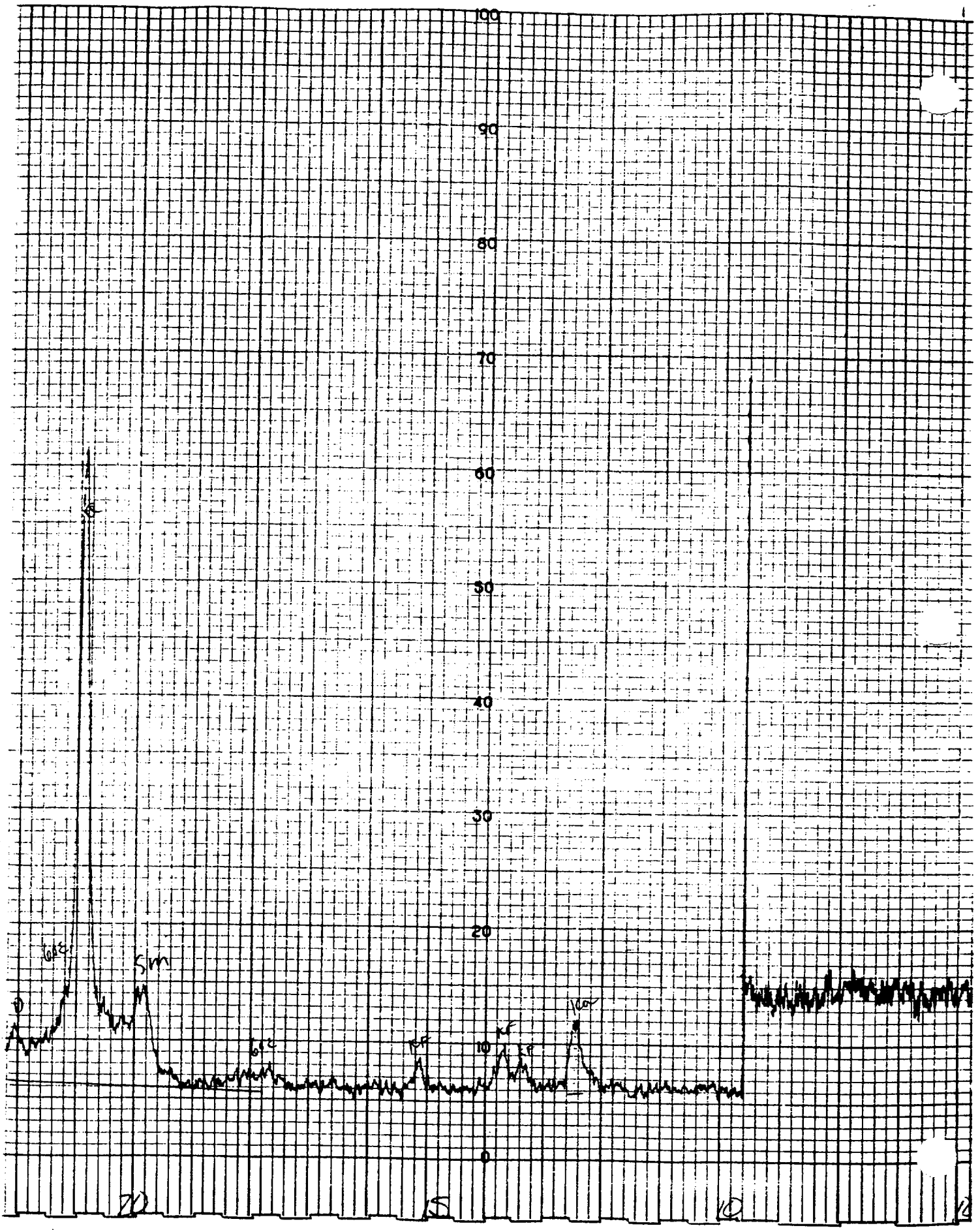

90
80
70
60
50
40
30
20
10
0

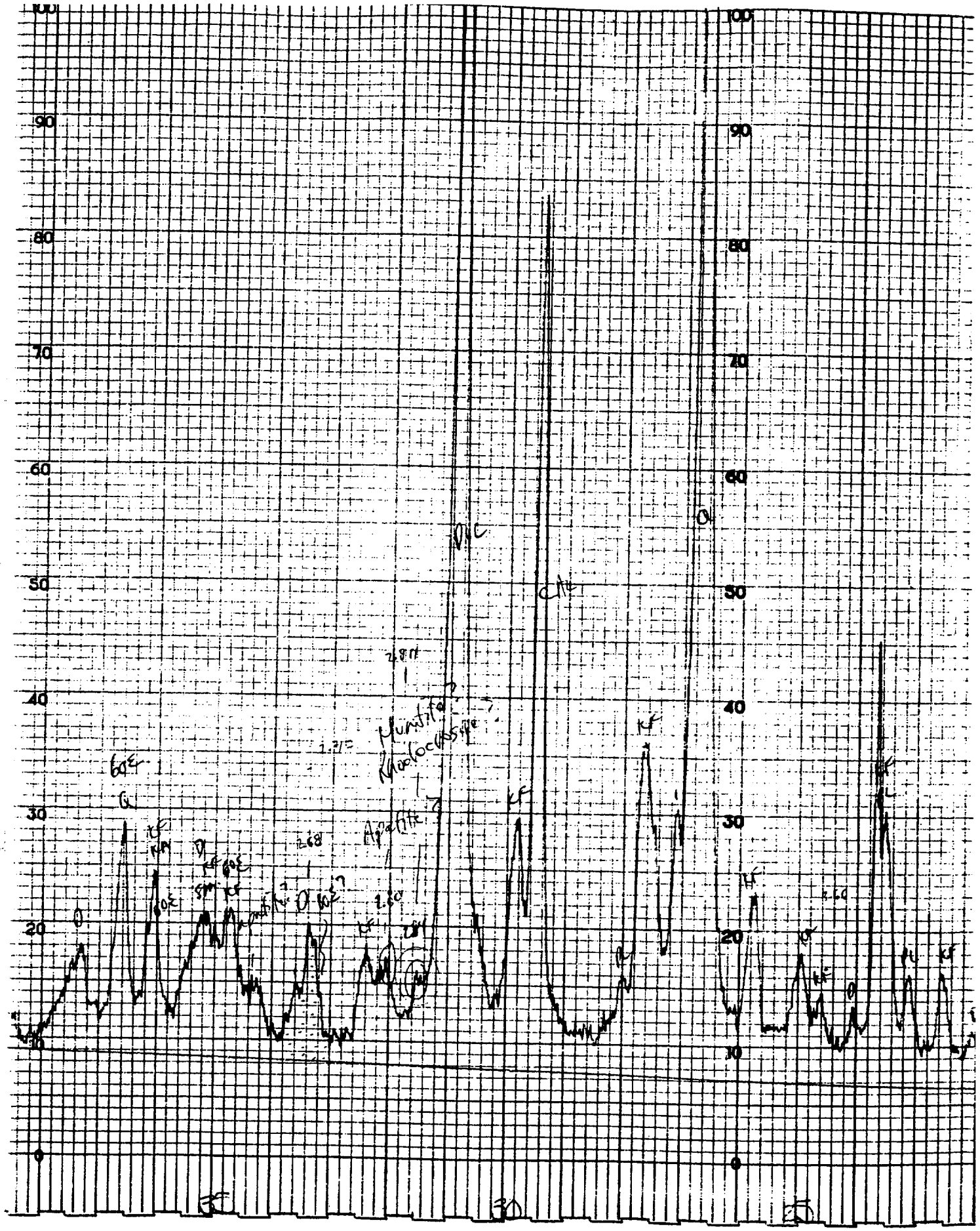

100
90
80
70
60
50
40
30
20
10
0
44%
PRINTED IN U.S.A.

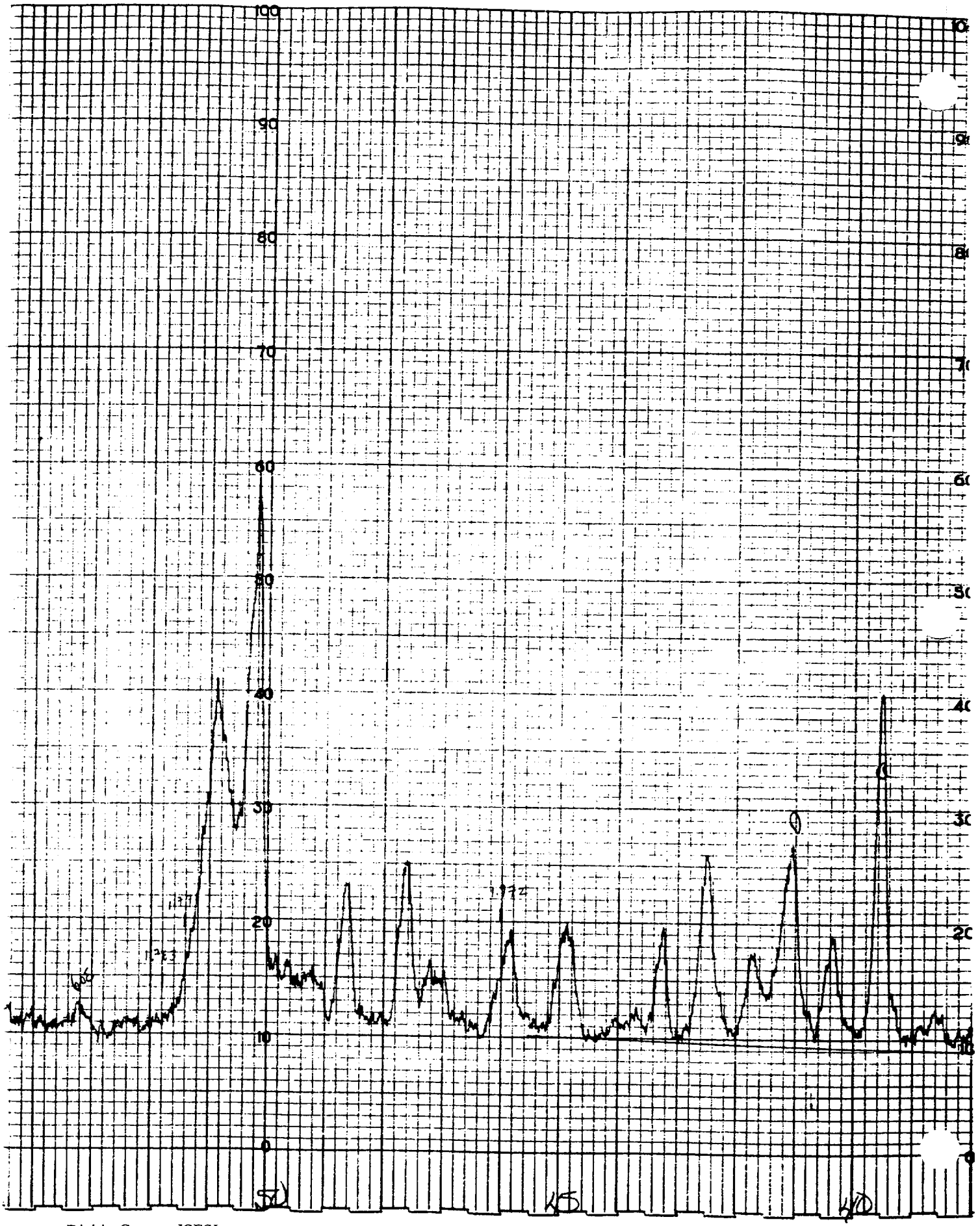

100
90
80
70
60
50
40
30
20
10
0
20
30
25
25%
R 25,000

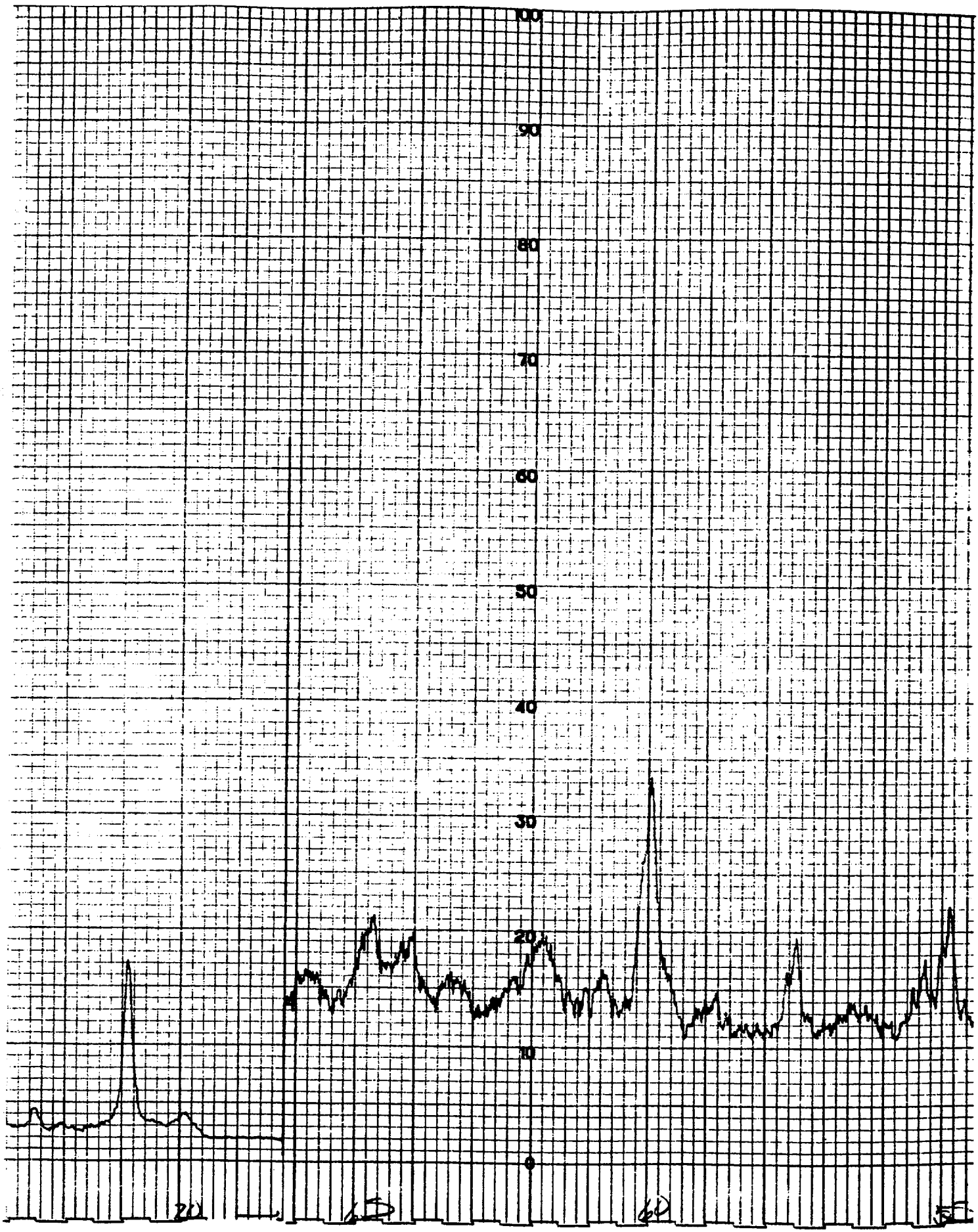

Qtr Sol
Standard
90
80
70
60
50
40
30
20
10
0
G

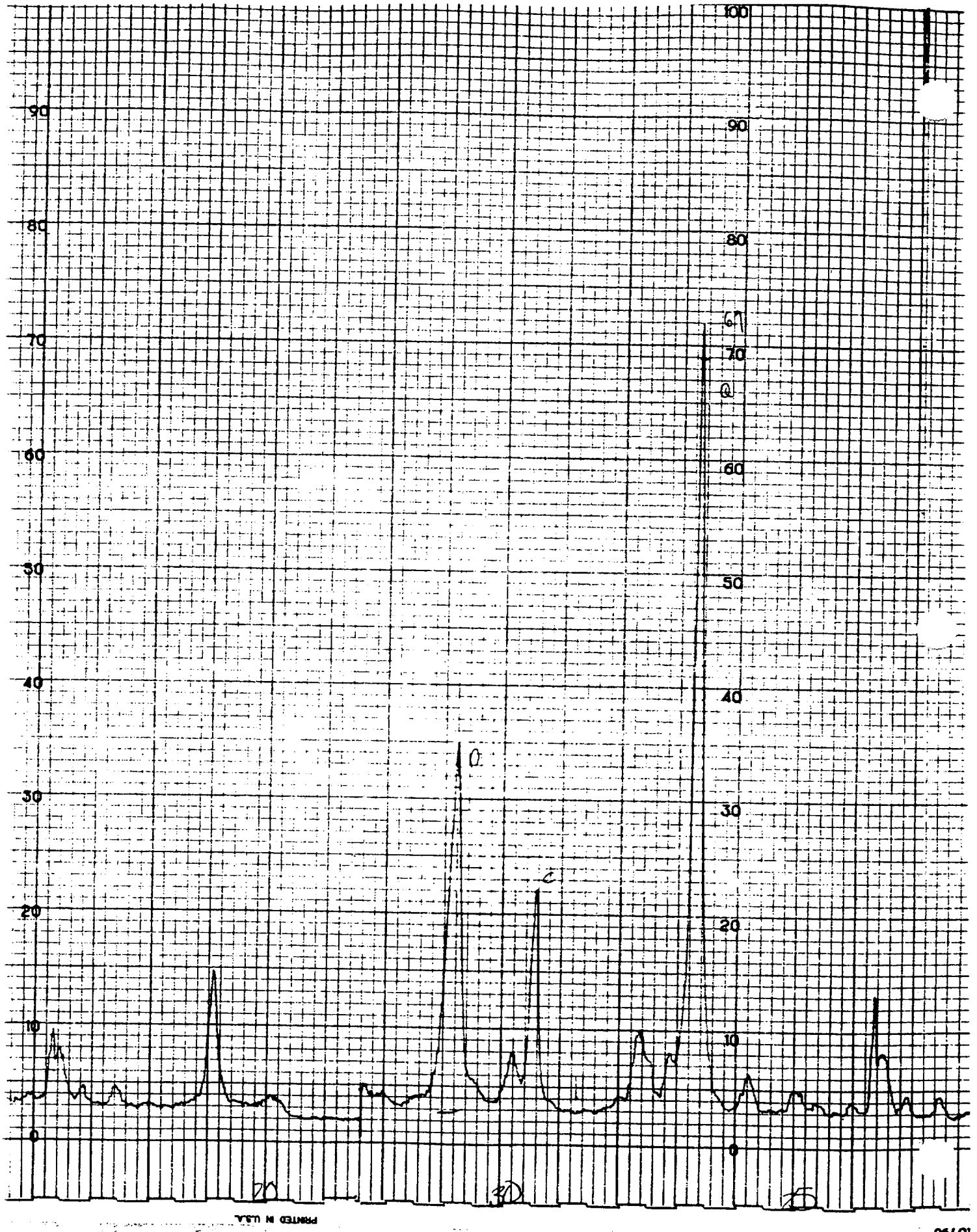

SPECTRUM PETROGRAPHICS
P-9
Bulk
1860
Q - 15
Pl - 2
Kf - 7
C - 10
D - 17 (ferroan ?)
60E - TR
KA - 3
Sm - 13
Slightly more yellow than C
2.80 Å apatite - B??
2.84 Å rhodochrosite ?
or
huntite ?
$Mg_3Ca(CO_3)_4$
100
90
80
70
60
50
40
30
20
10
0

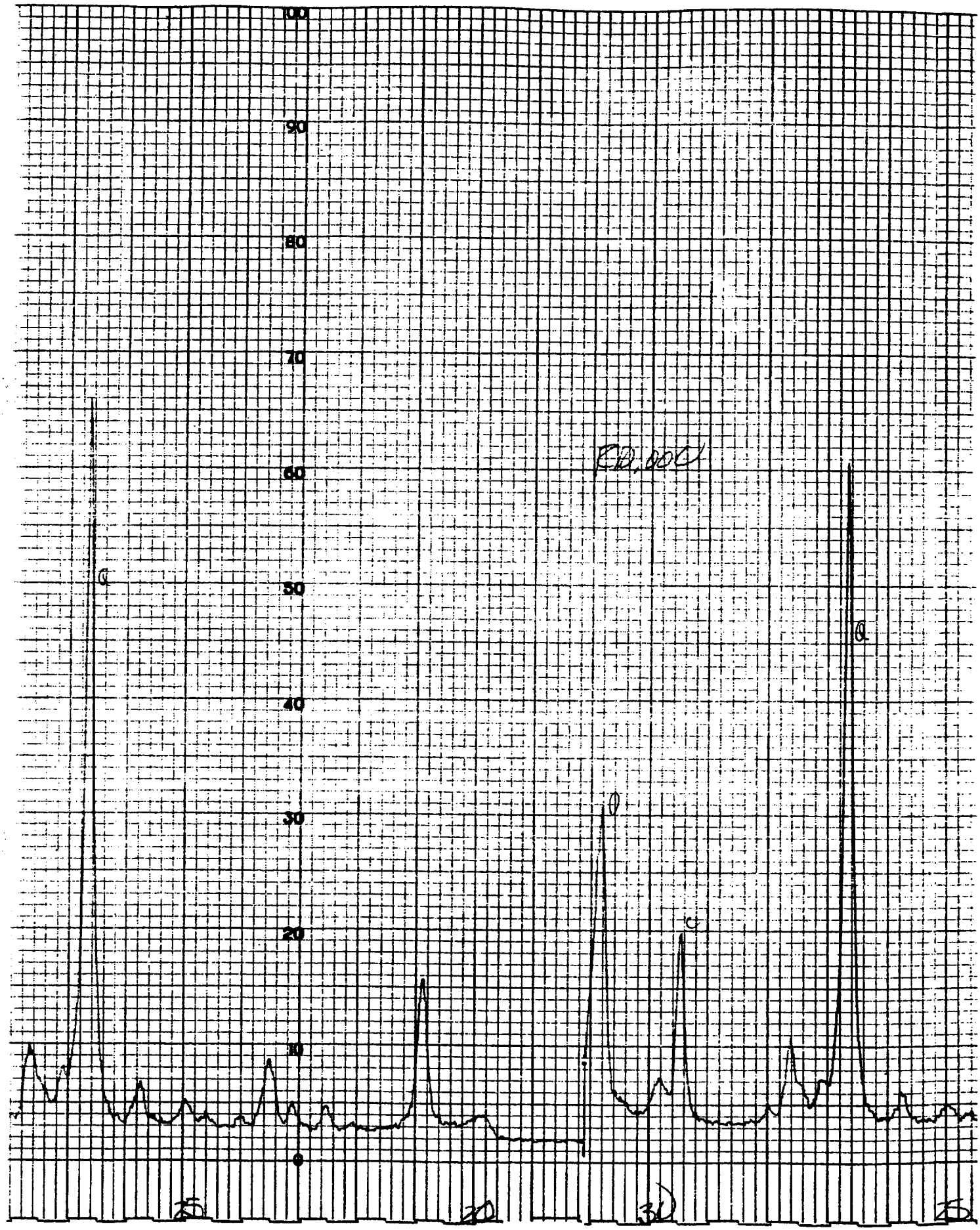

100
90
80
70
60
50
40
30
20
10
0
5m
10

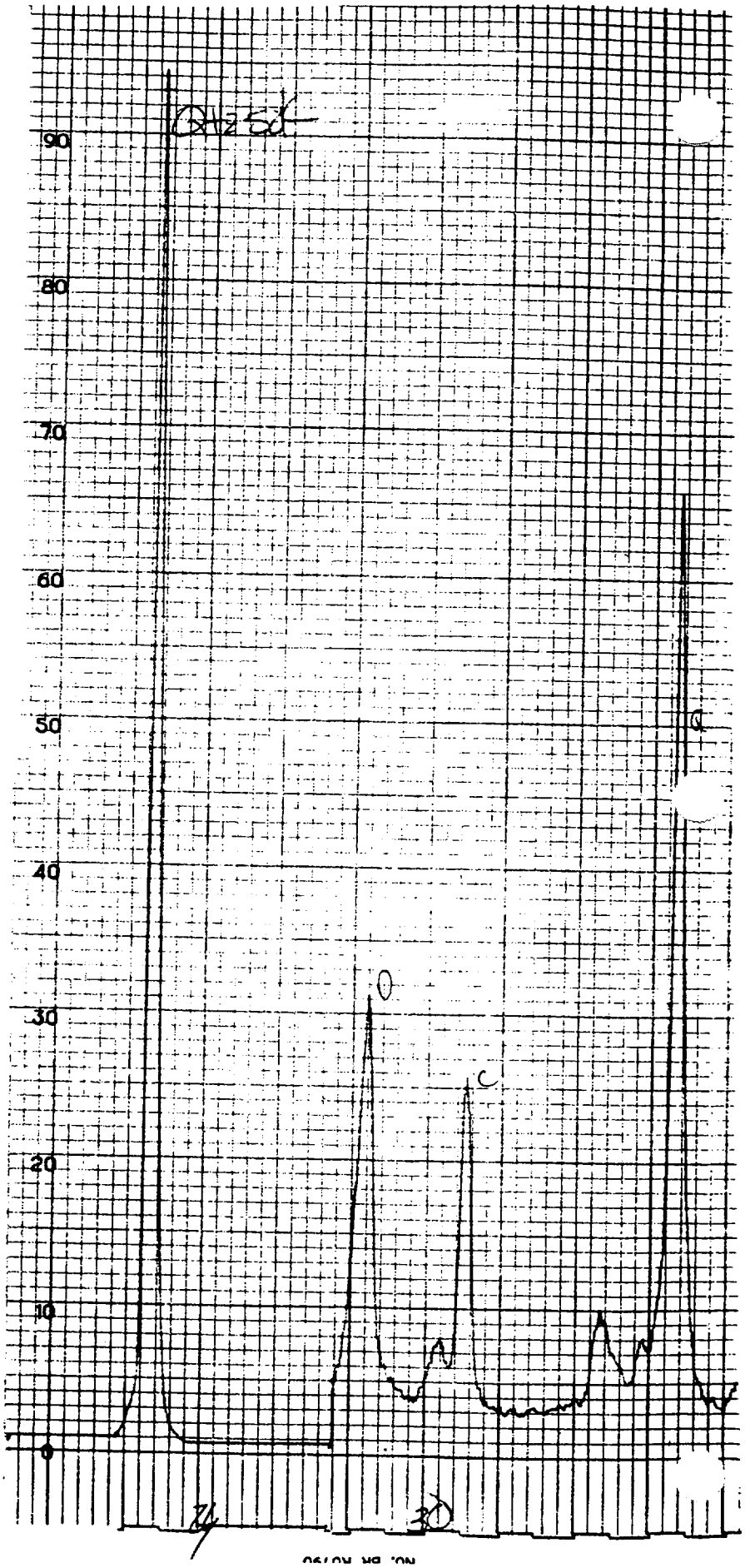

100
90
80
70
60
50
40
30
20
10
0
Muntifa
Apatite

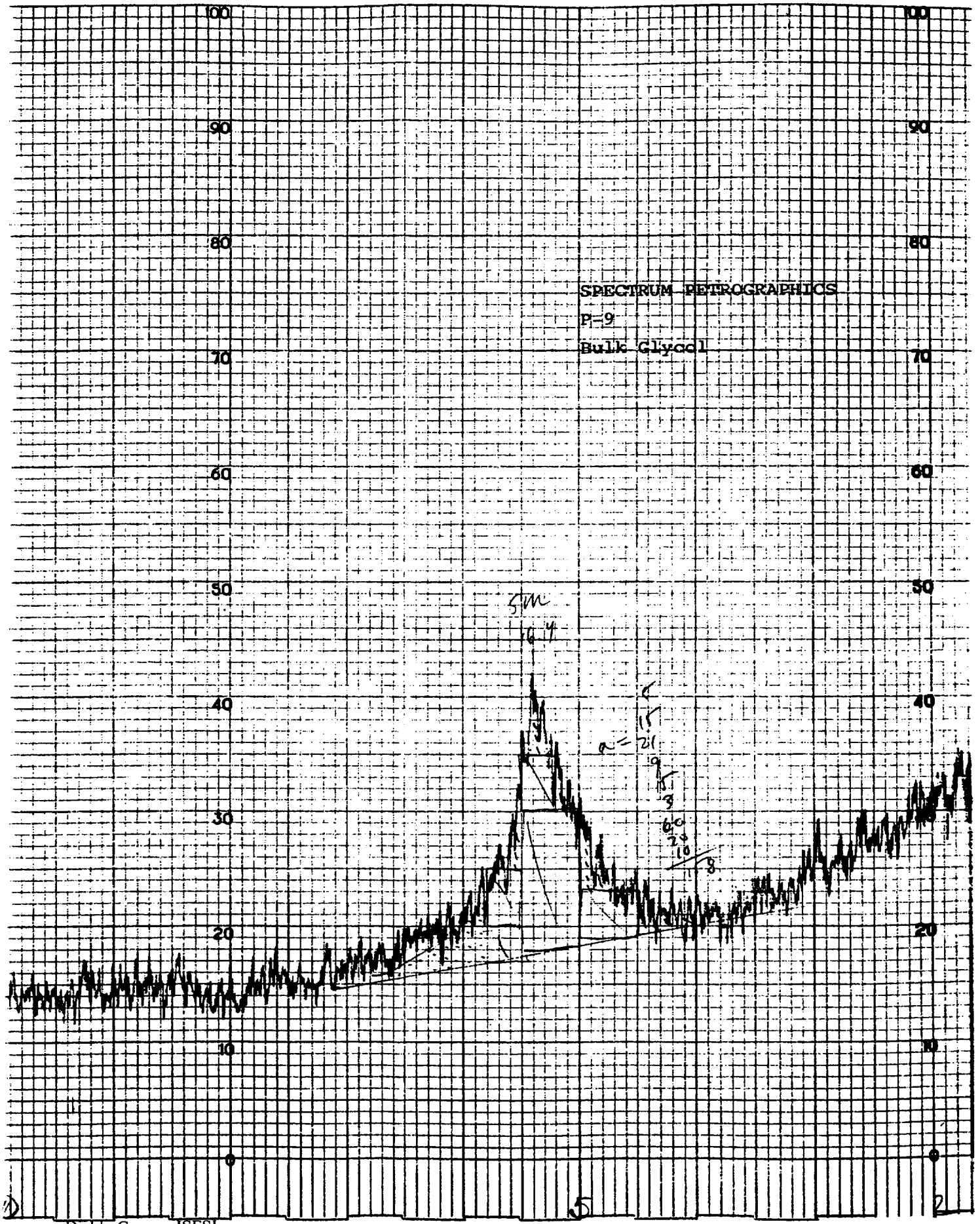

100
90
80
70
60
50
40
30
20
10
0
50
45
40

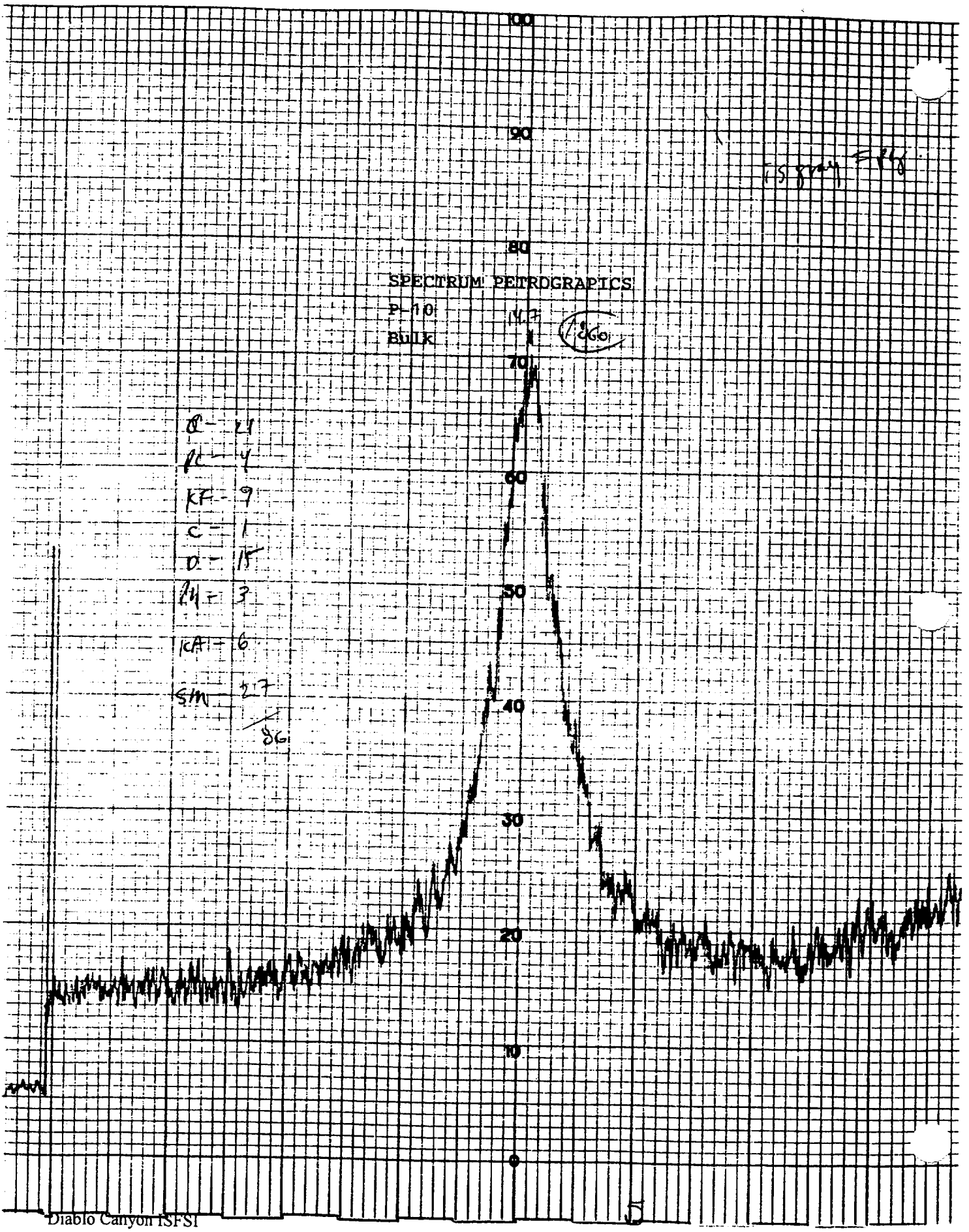

100
90
80
70
60
50
40
30
20
10
0
20
40
60

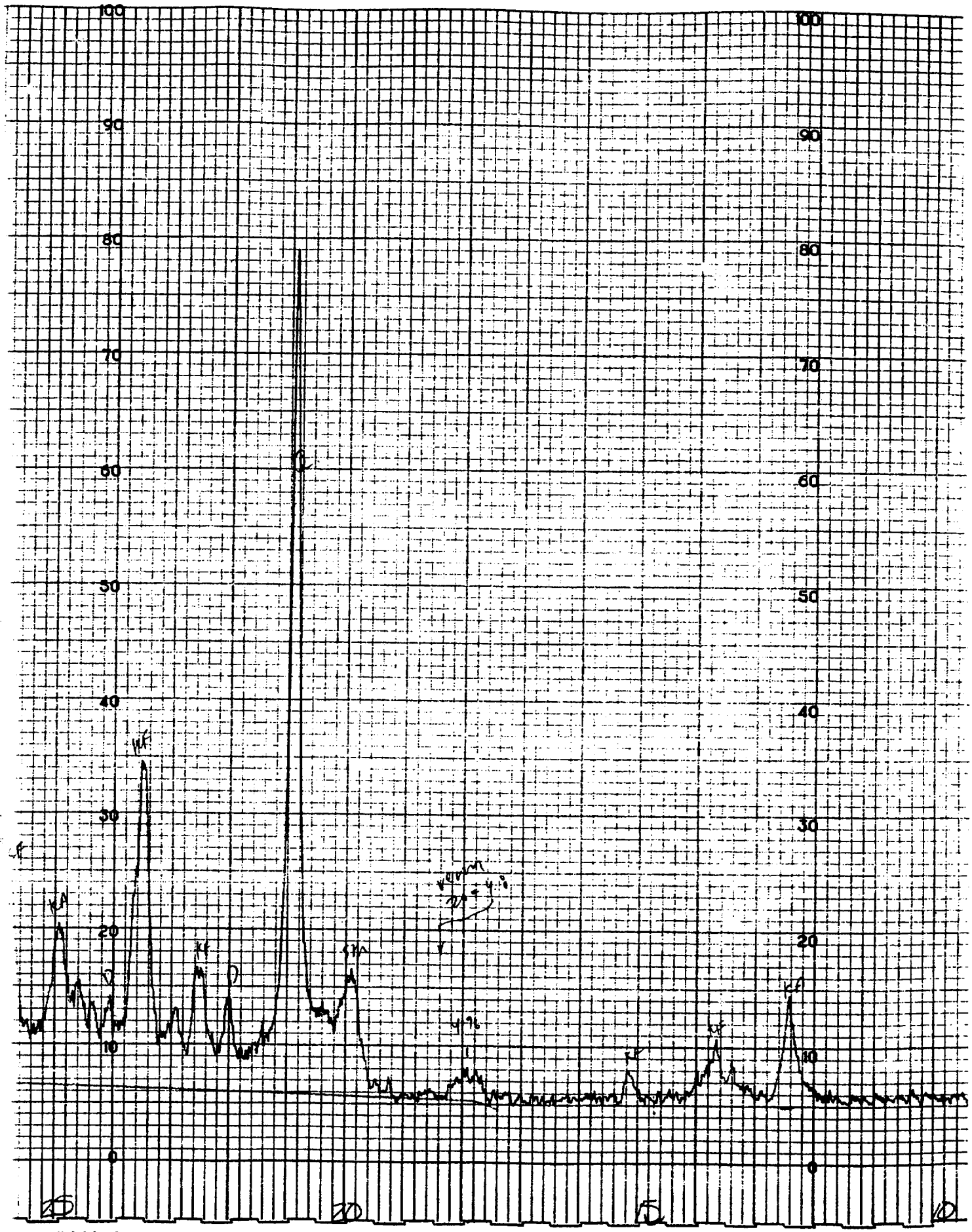

100
90
80
70
60
50
40
30
20
10
0
a
c

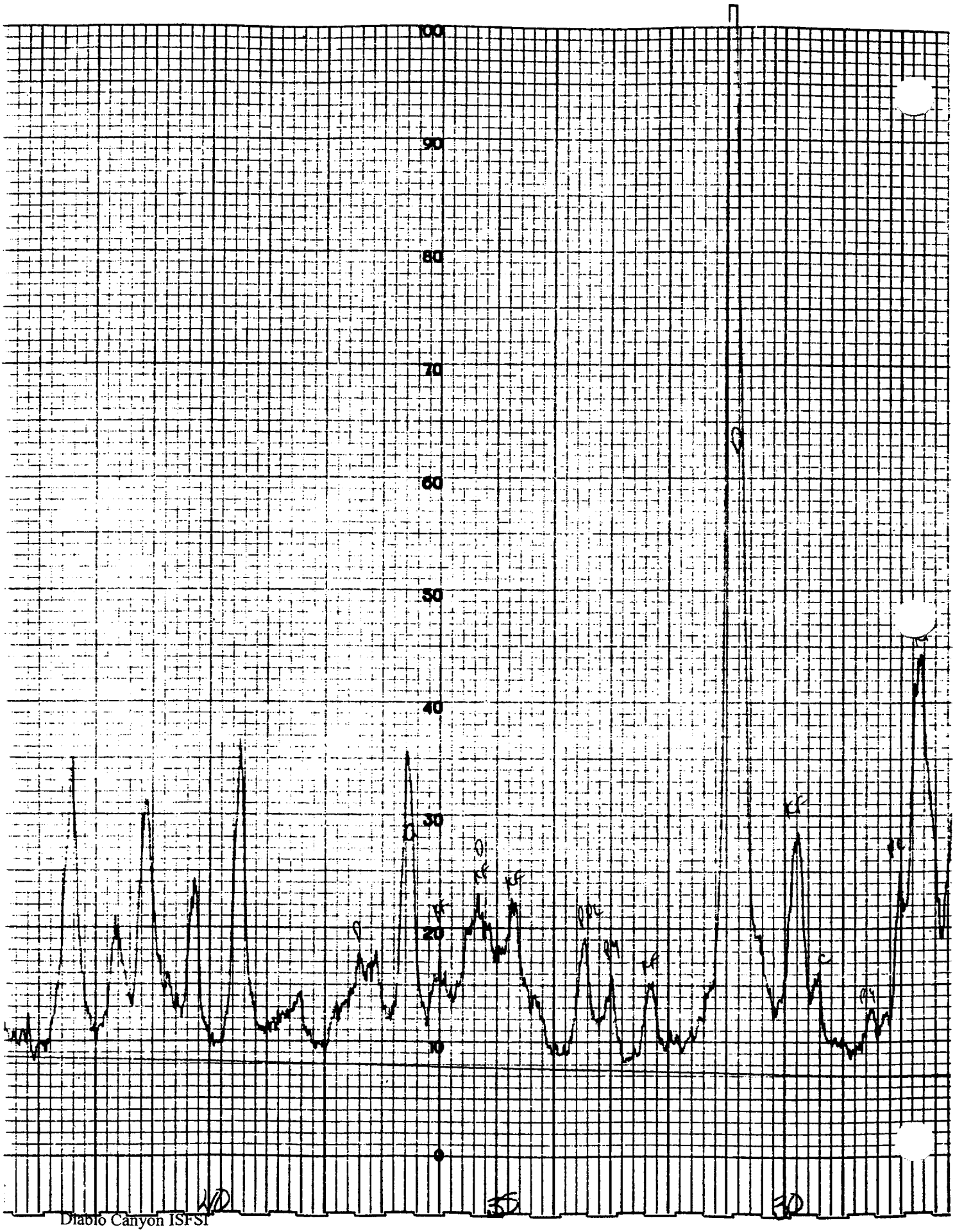

100
90
80
70
60
50
40
30
20
10
0
a
b
c
d
25
20
30
35

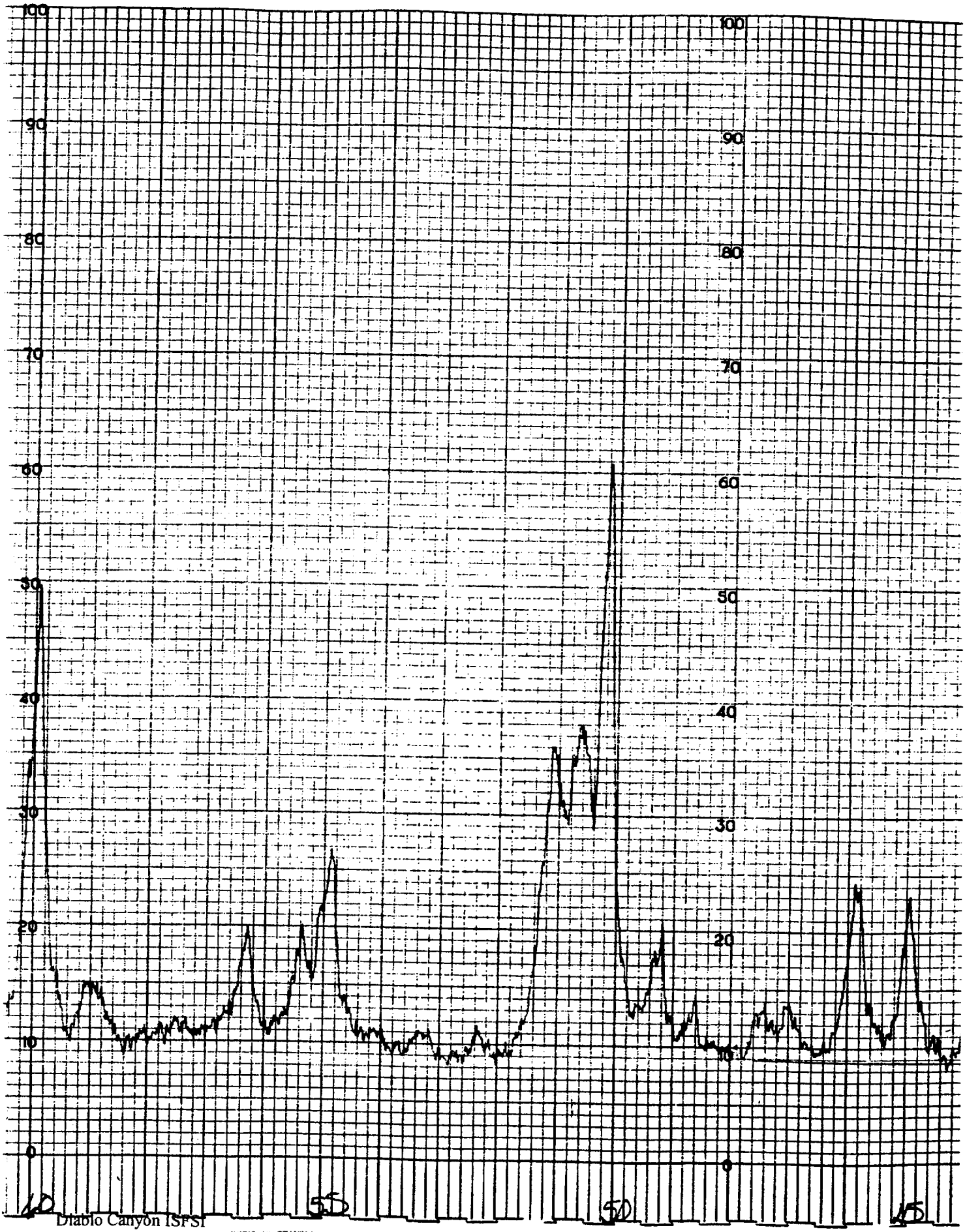

90
80
70
60
50
40
30
20
10
0
O
C
a

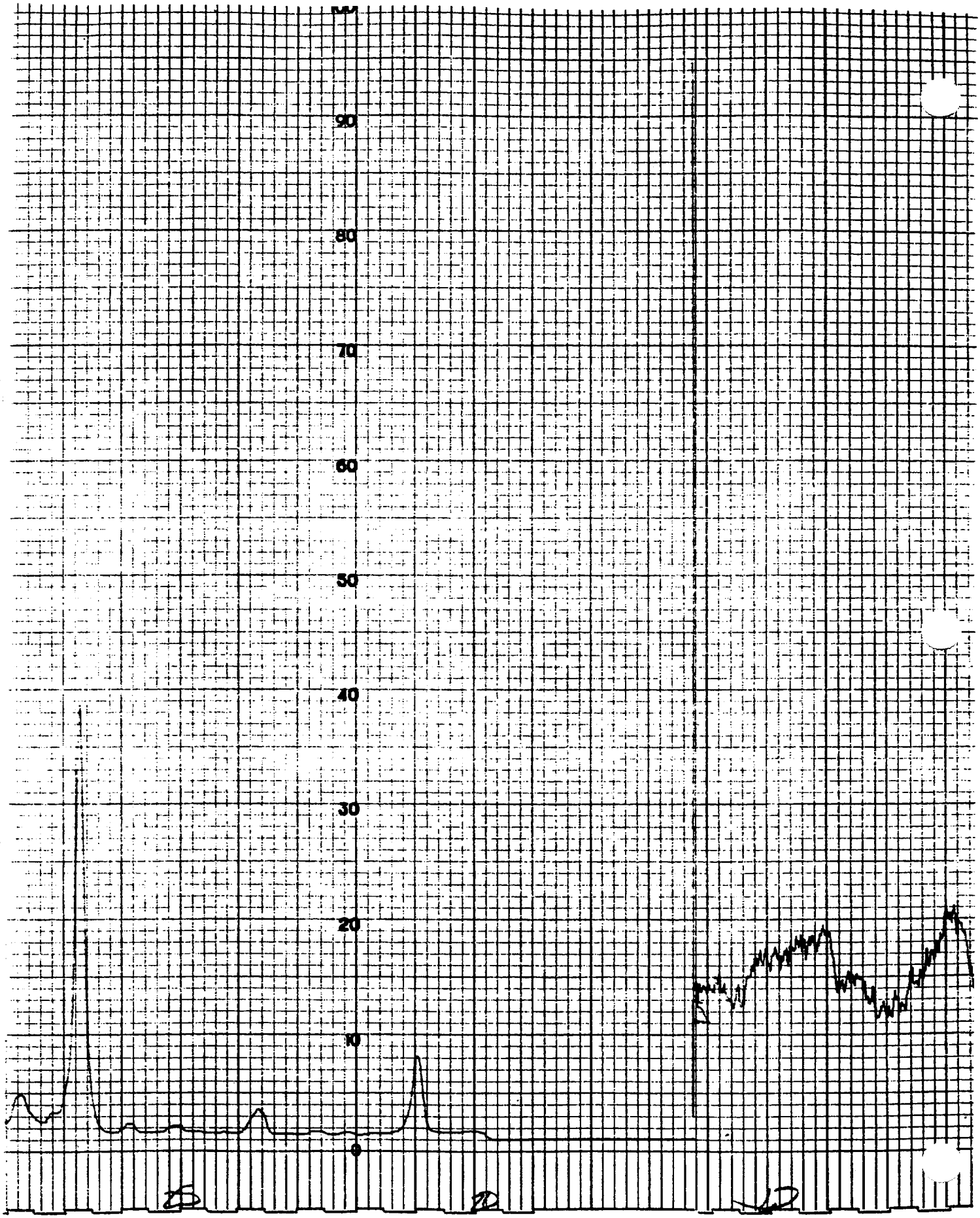

SPECTRUM PETROGRAPHICS
P-9
Bulk Glycol
100
90
80
70
60
50
40
30
20
10
0

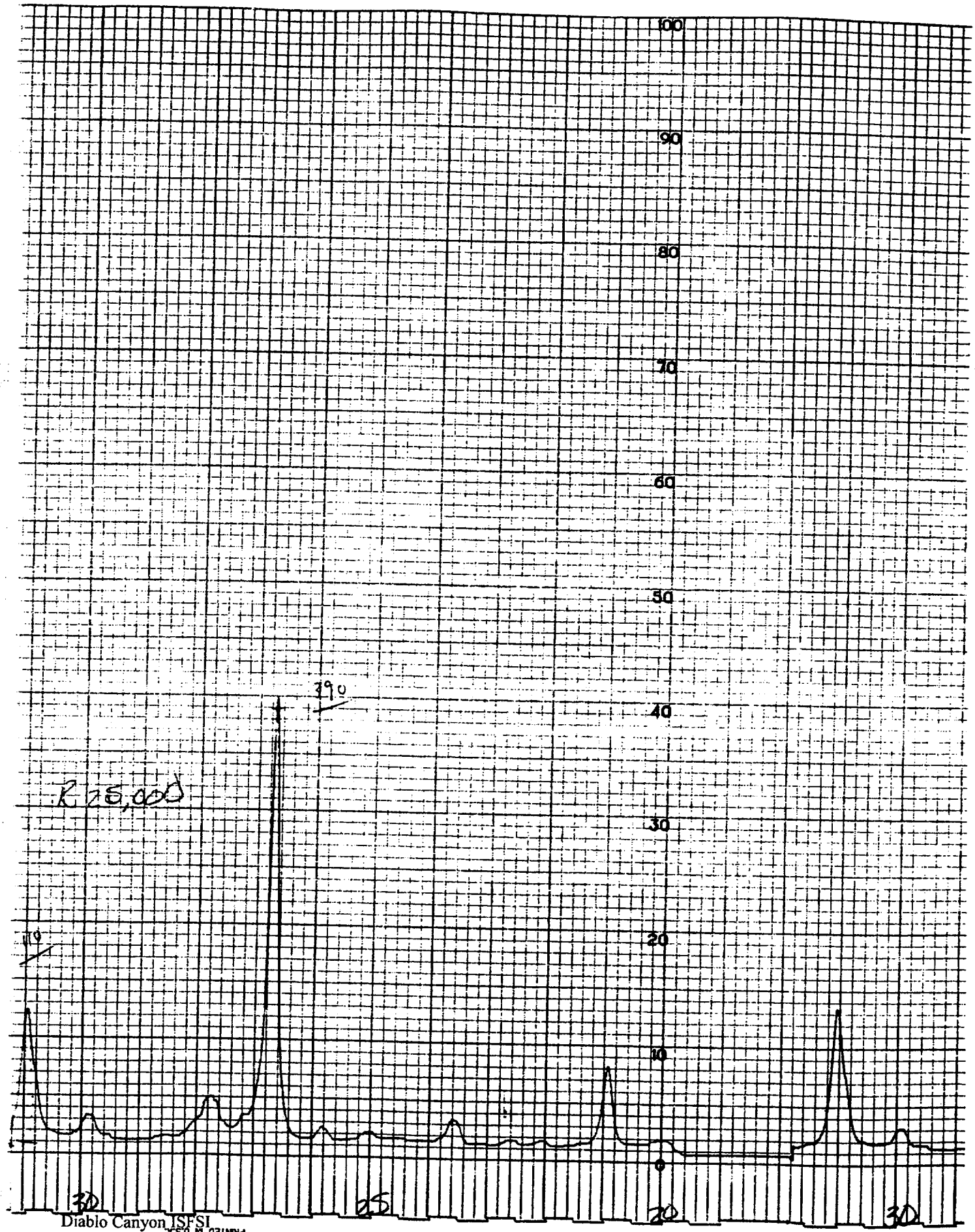

100
90
80
70
60
50
40
30
20
10
0
SPECTRUM PETROGRAPHICS
P-10
BULK
Q - 24
PL - 4
KF - 9
C - 1
O - 15
M - 3
CA - 6
SM - 27
86

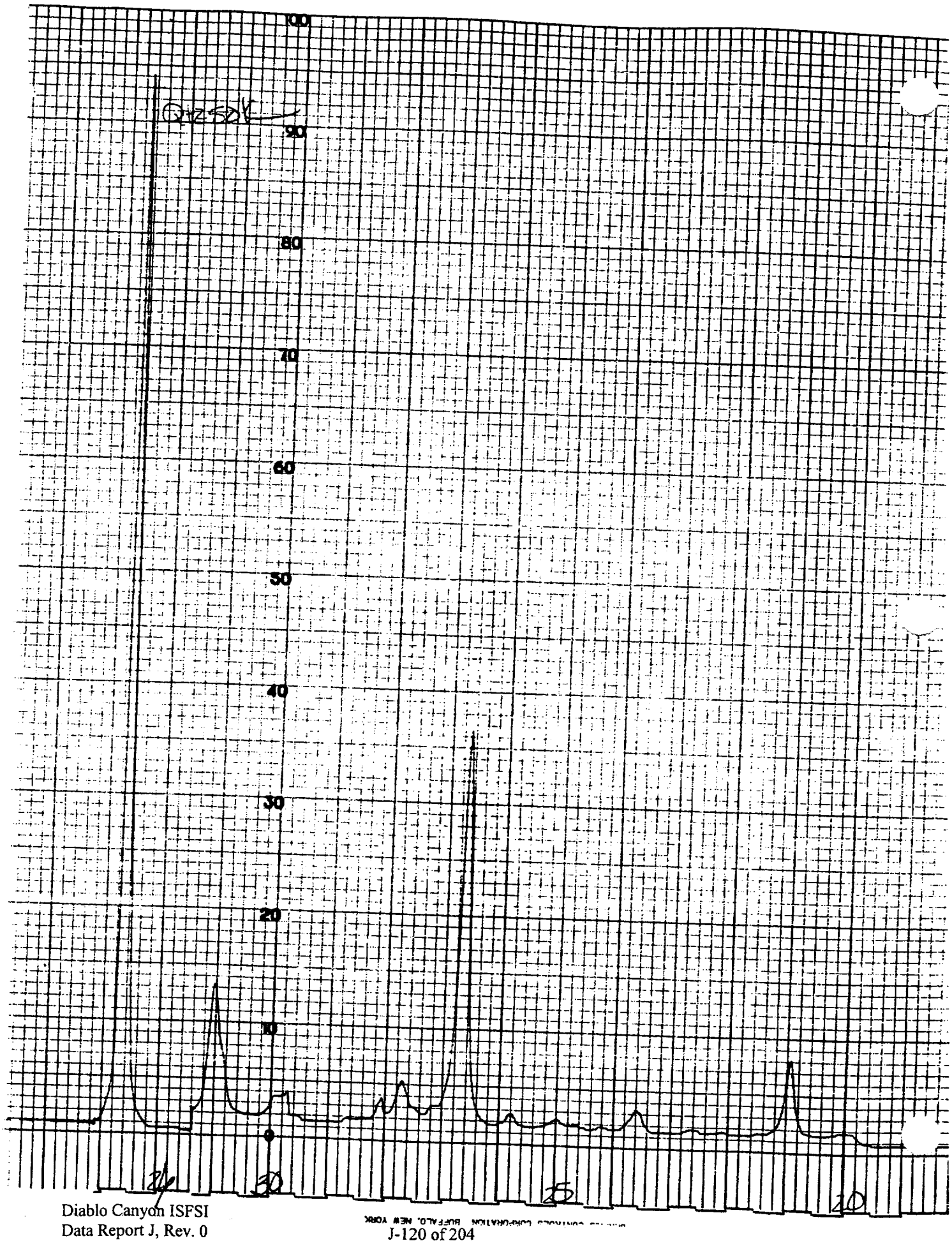

100
90
80
70
60
50
40
30
20
10
0
45
30
15
0

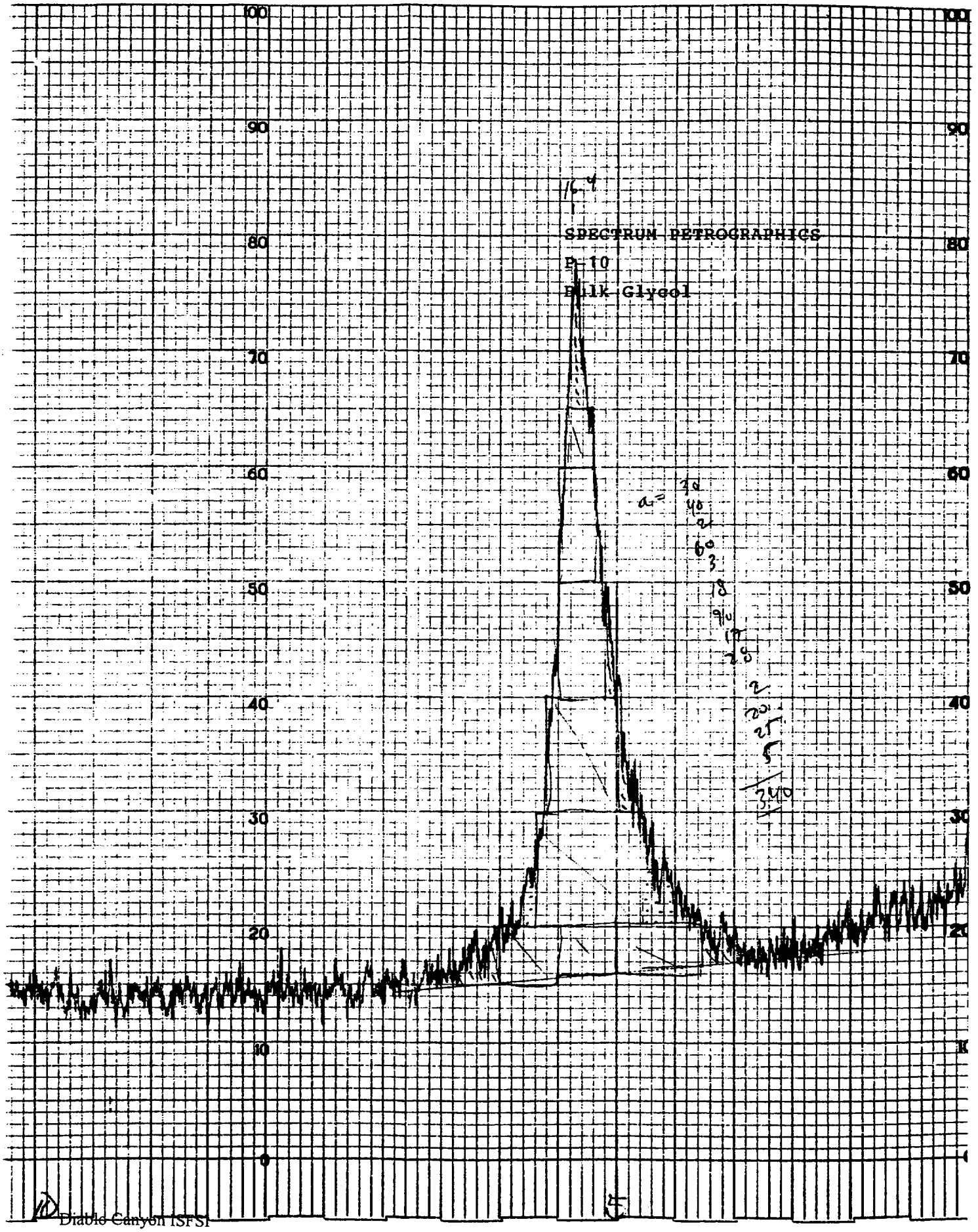

100
90
80
70
60
50
40
30
20
10
0

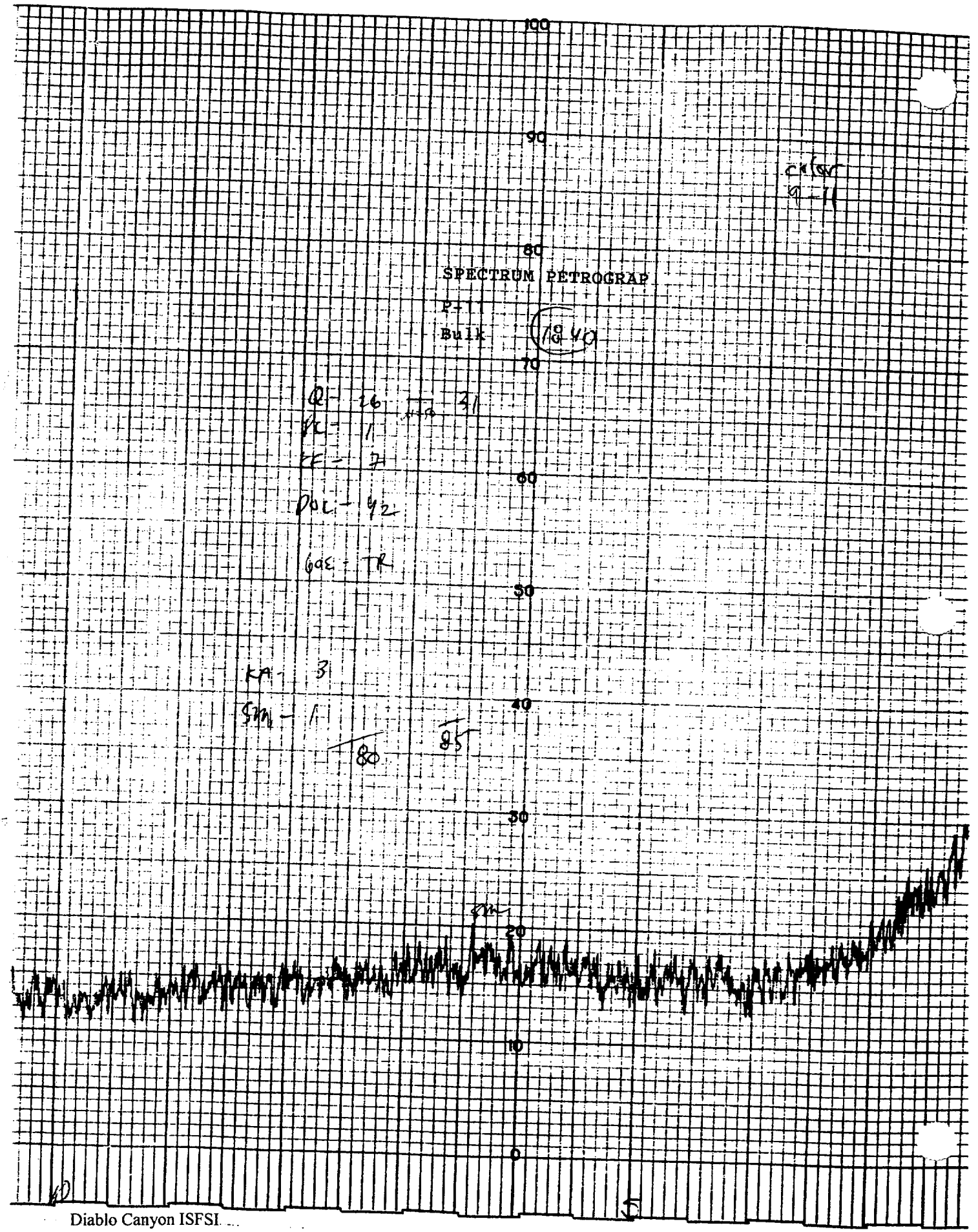

100
90
80
70
60
50
40
30
20
10
0
100
90
80
70
60
50
40
30
20
10
0
40
55
50
45

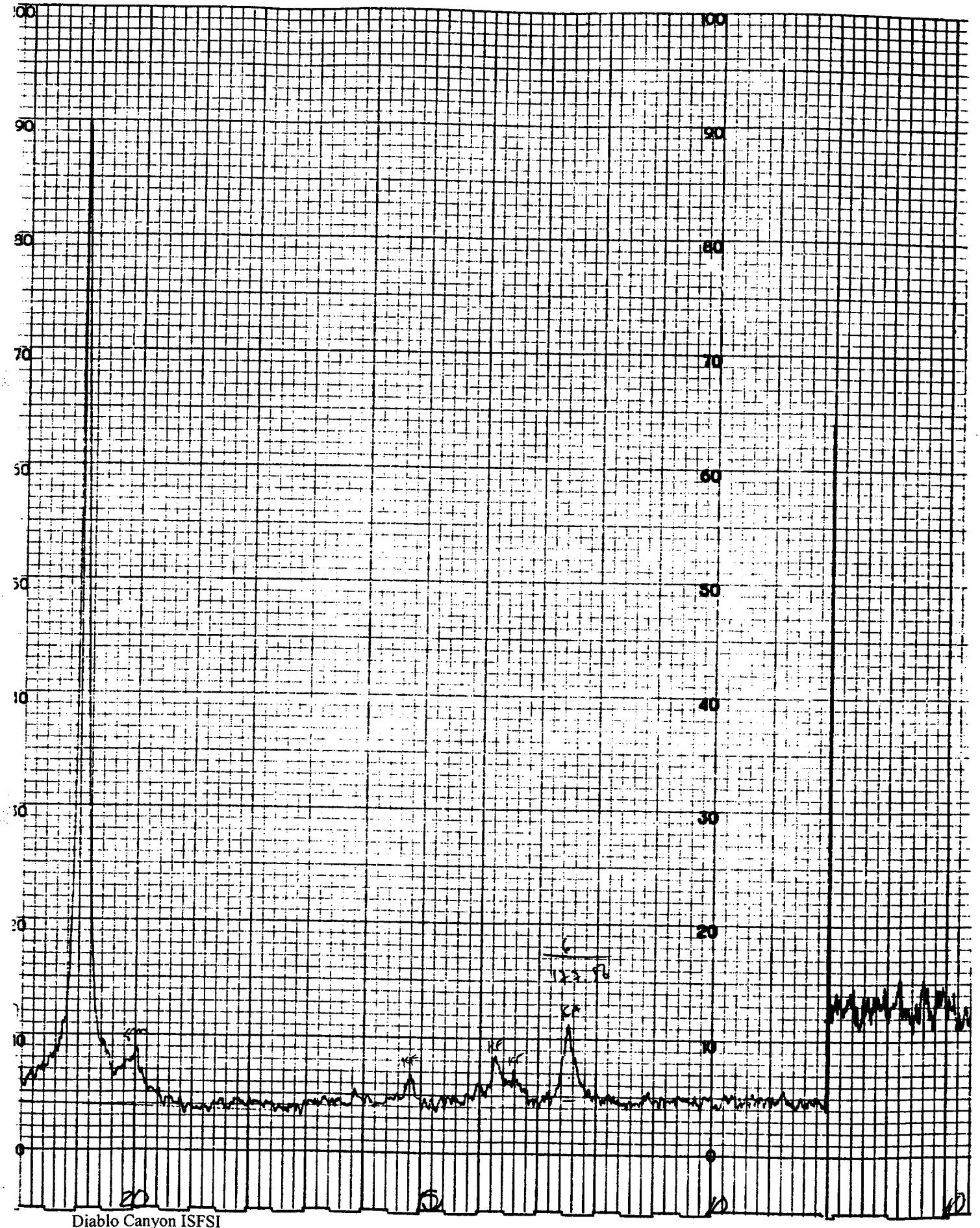

90
80
70
60
50
40
30
20
10
0

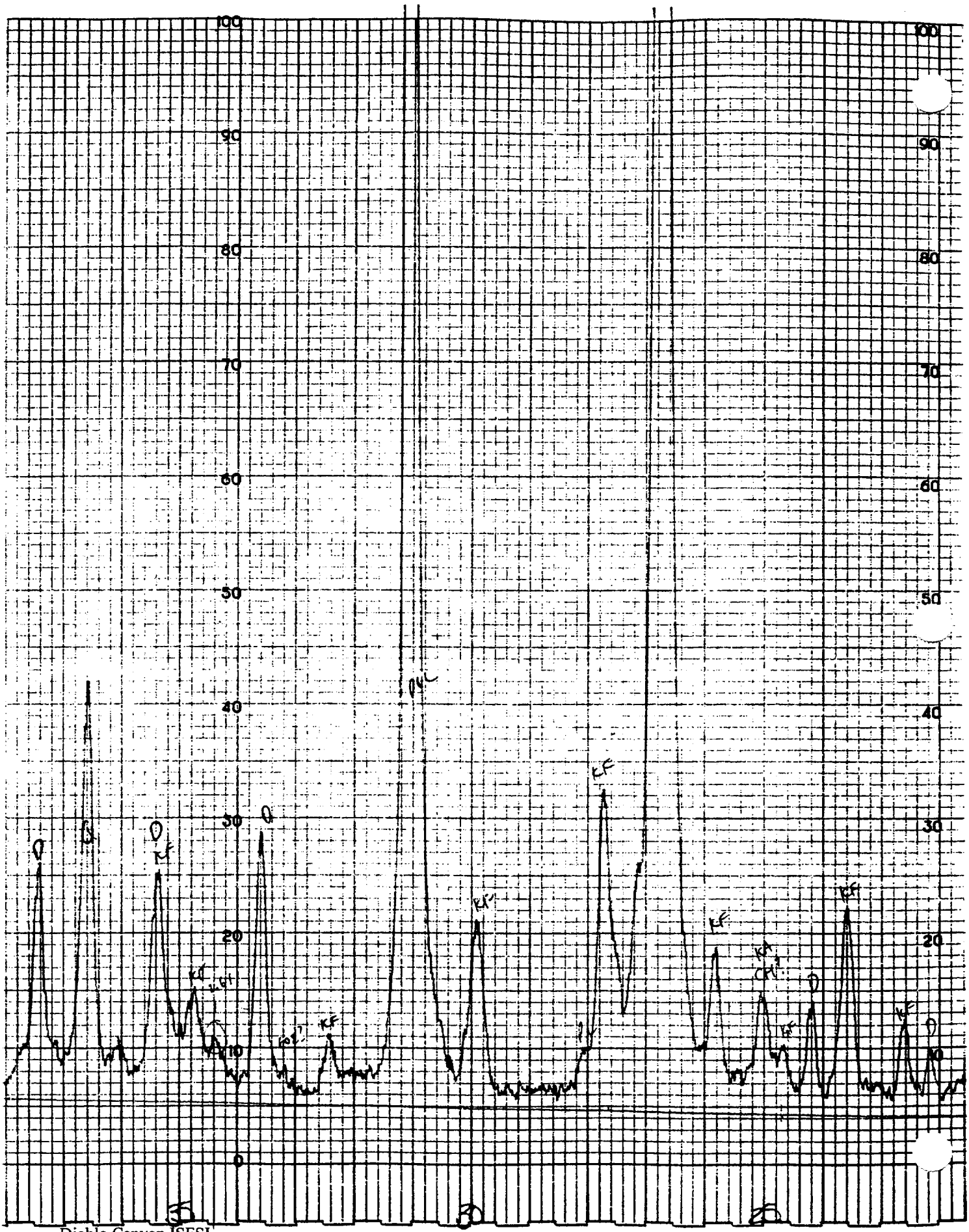

100
90
80
70
60
50
40
30
20
10
0
10
390
R 25,000
30
25
20
30

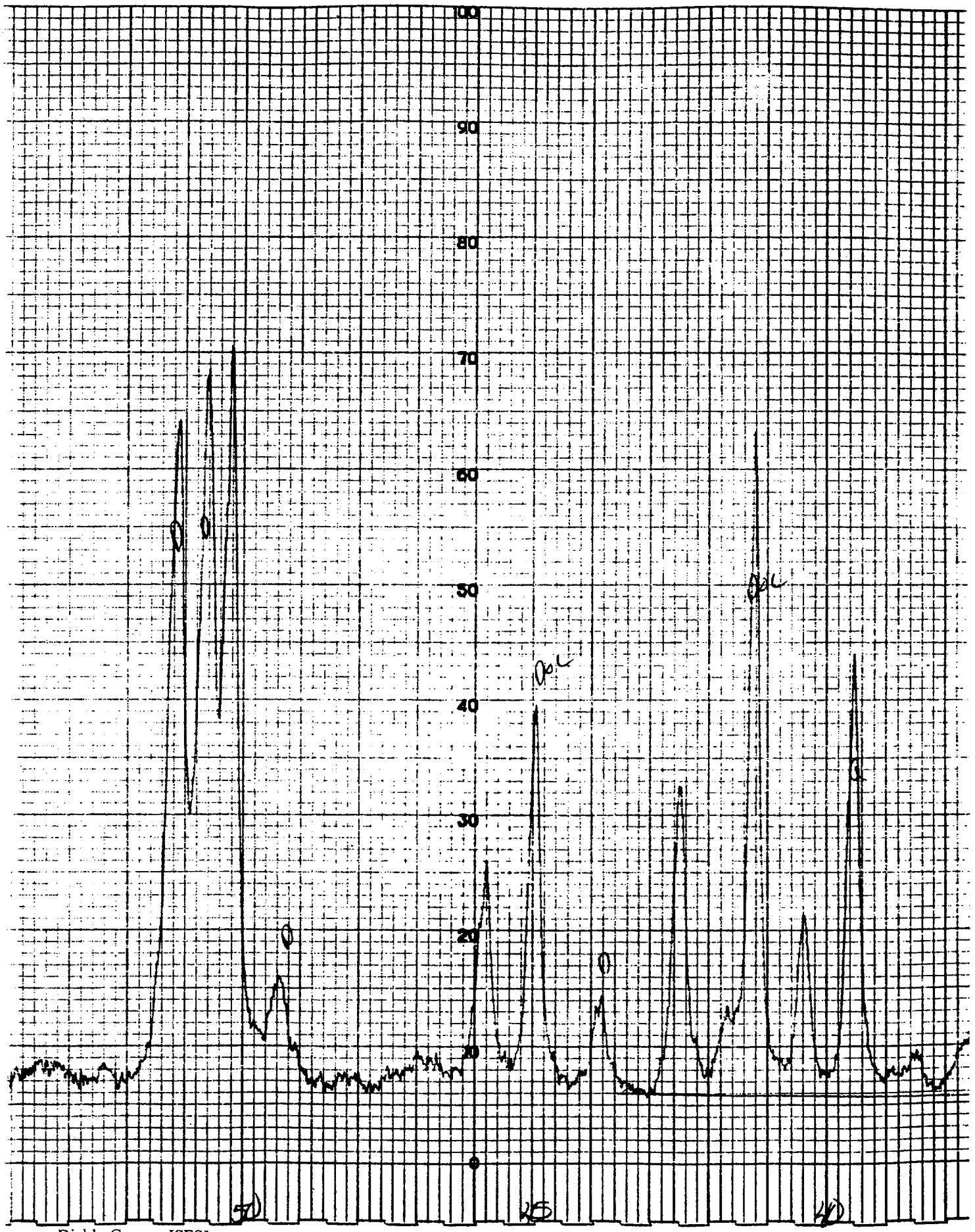

100
90
80
70
60
50
40
30
20
10
0
30
25
20

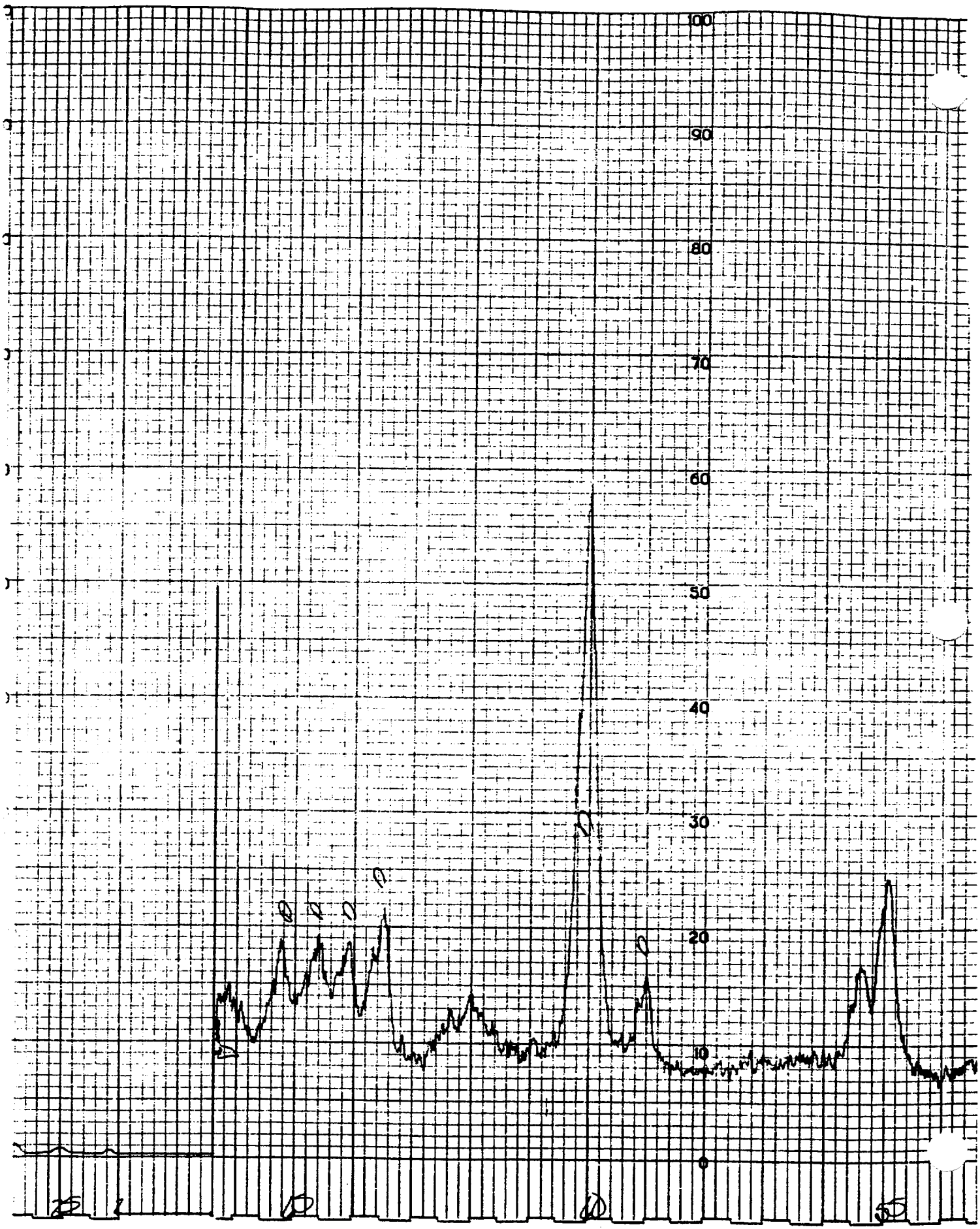

SPECTRUM PETROGRAPHICS
P-10
Bulk Glycol
100
90
80
70
60
50
40
30
20
10
0

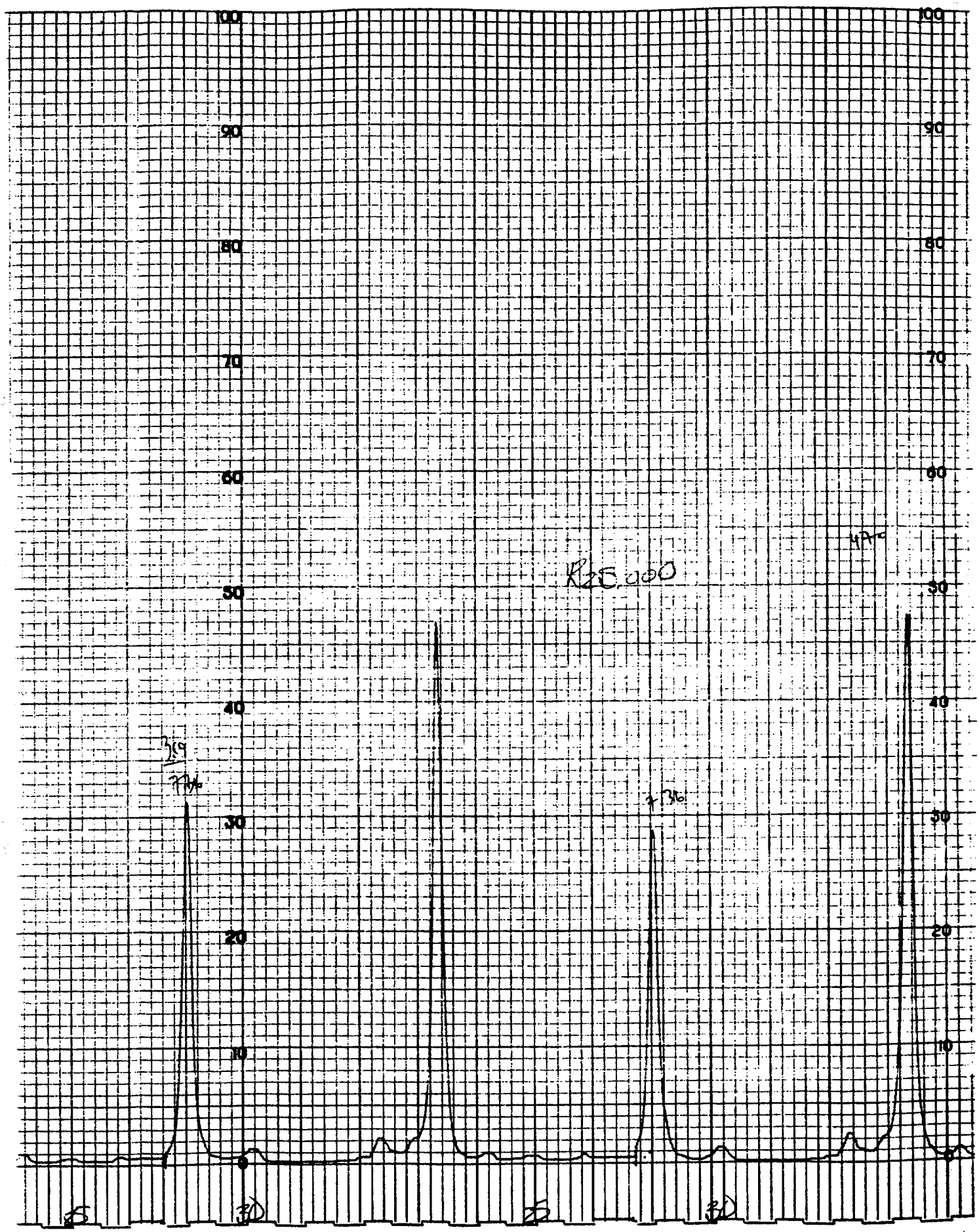

100
90
80
SPECTRUM PETROGRAP
P-11
Bulk
70
60
50
40
30
20
10
0


100
90
80
70
60
50
40
30
20
10
0

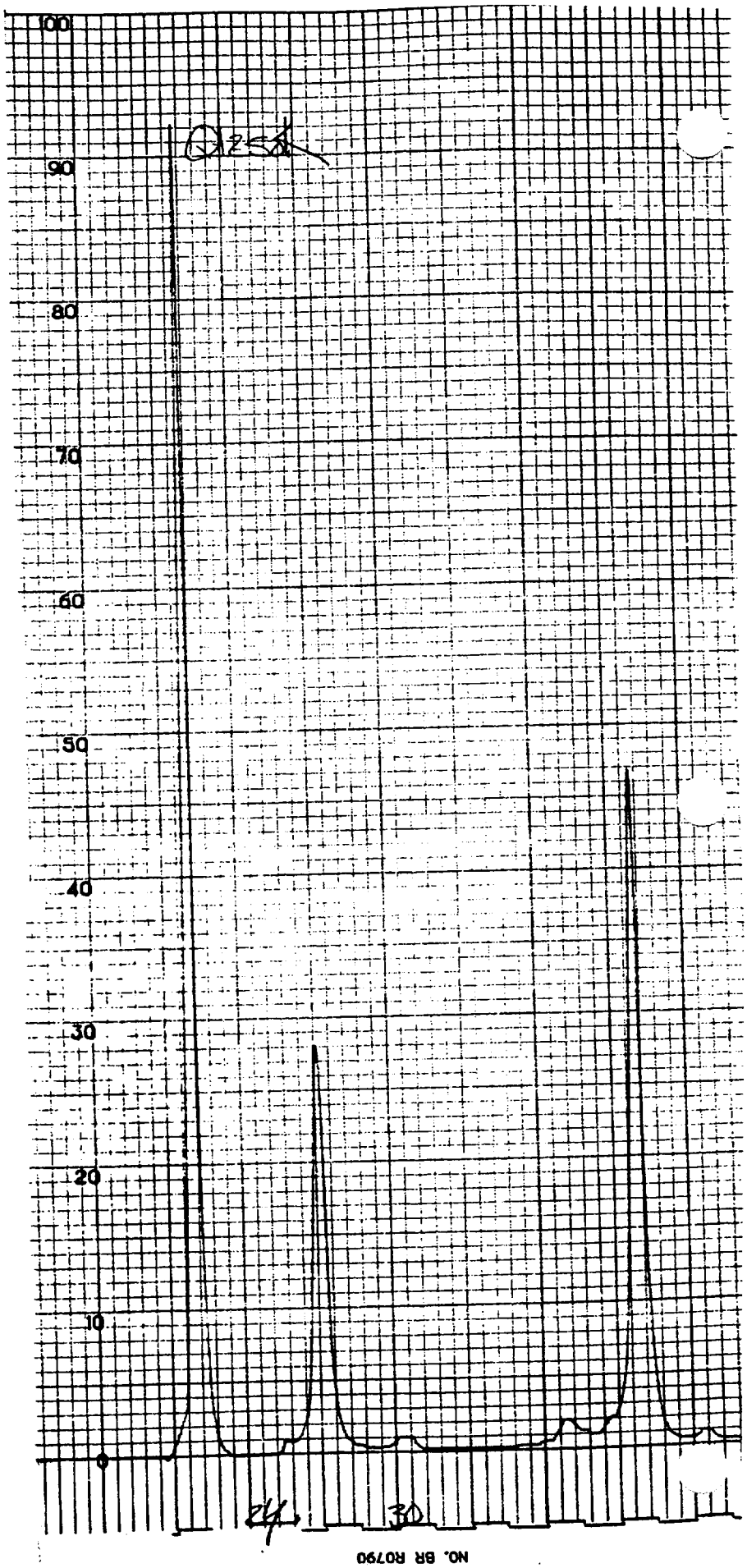

100
90
80
70
60
50
40
30
20
10
0
35
30
25

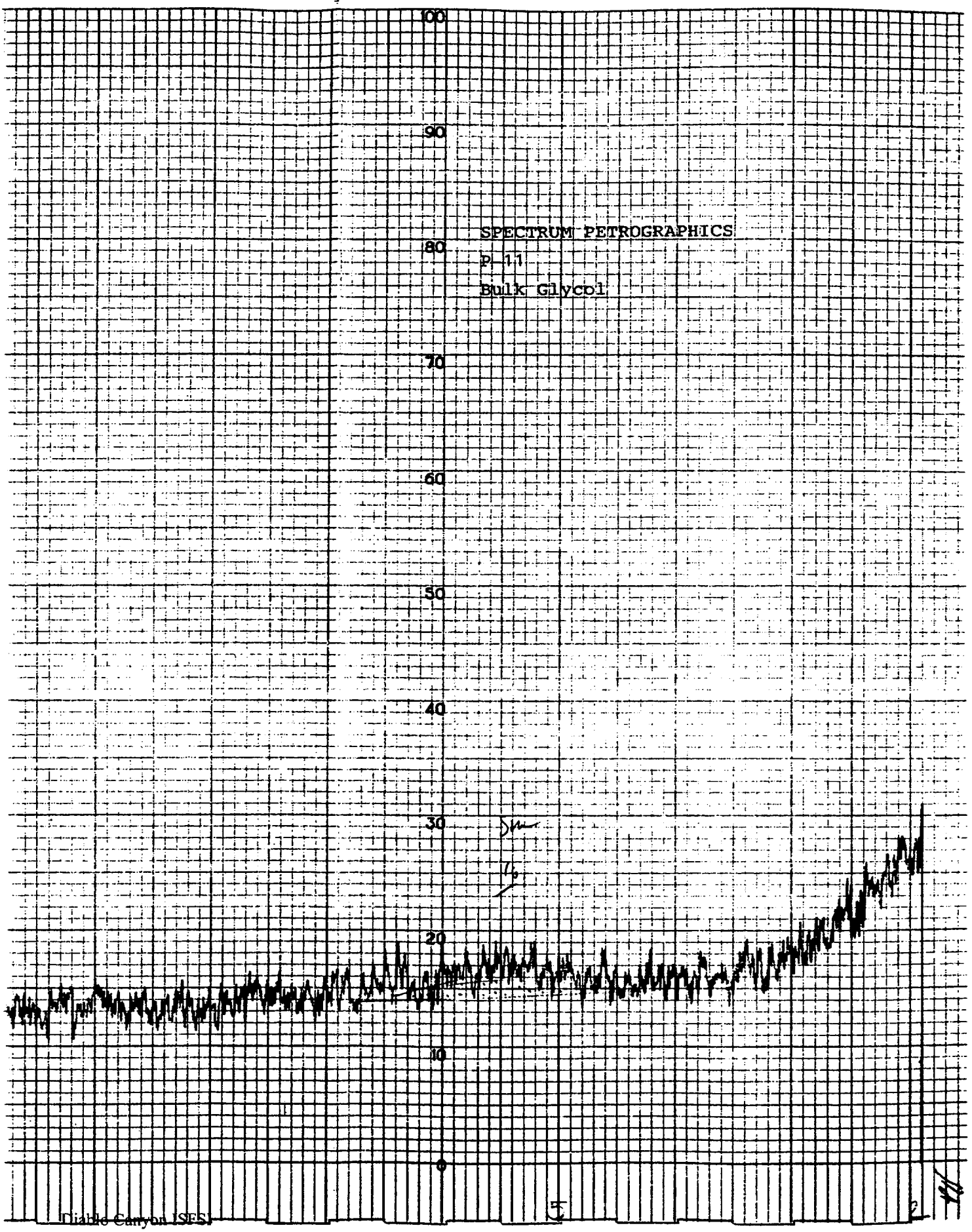

100
90
80
70
60
50
40
30
20
10
0
50
45
40

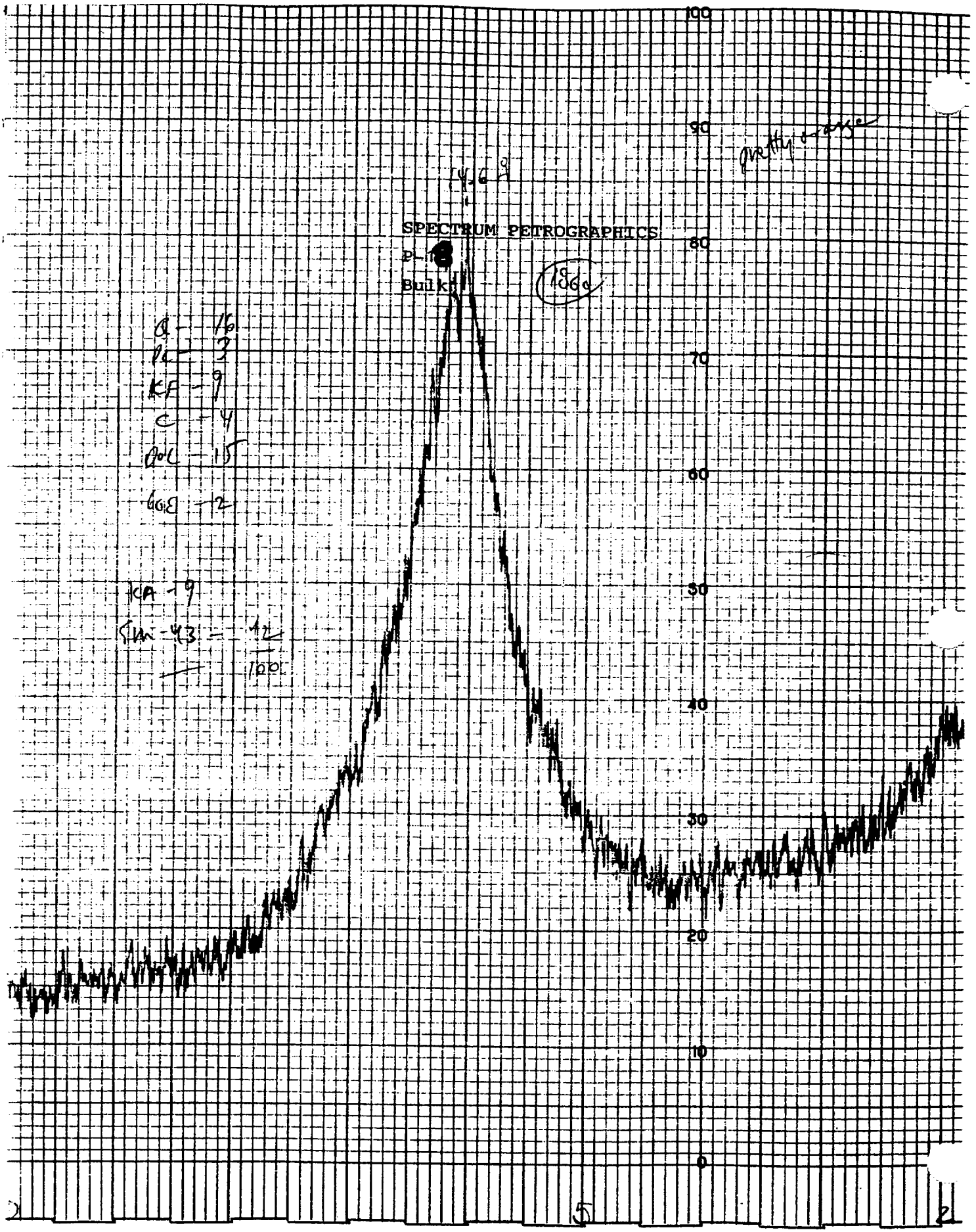

100
90
80
70
60
50
40
30
20
10
0
25
15
10
55

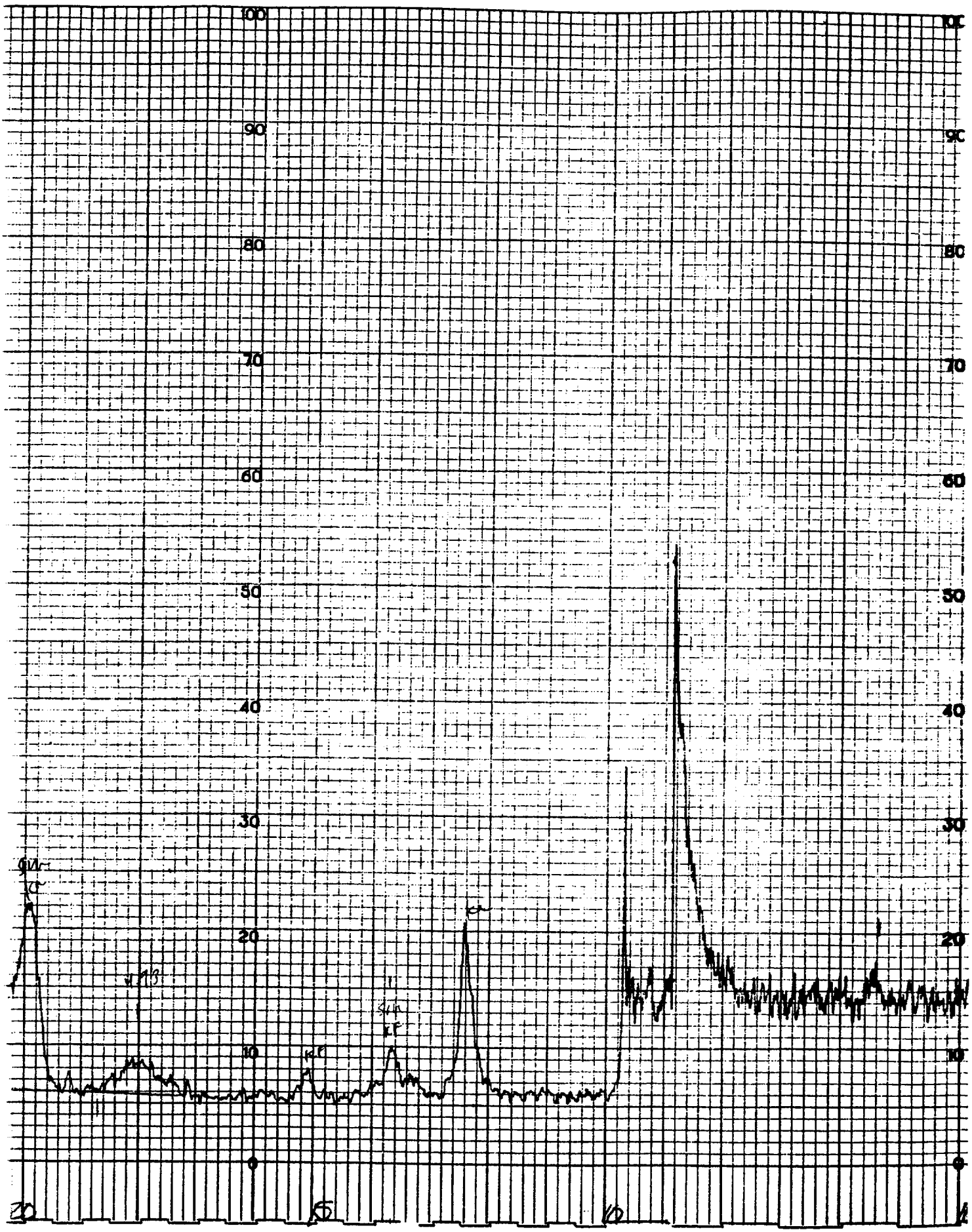


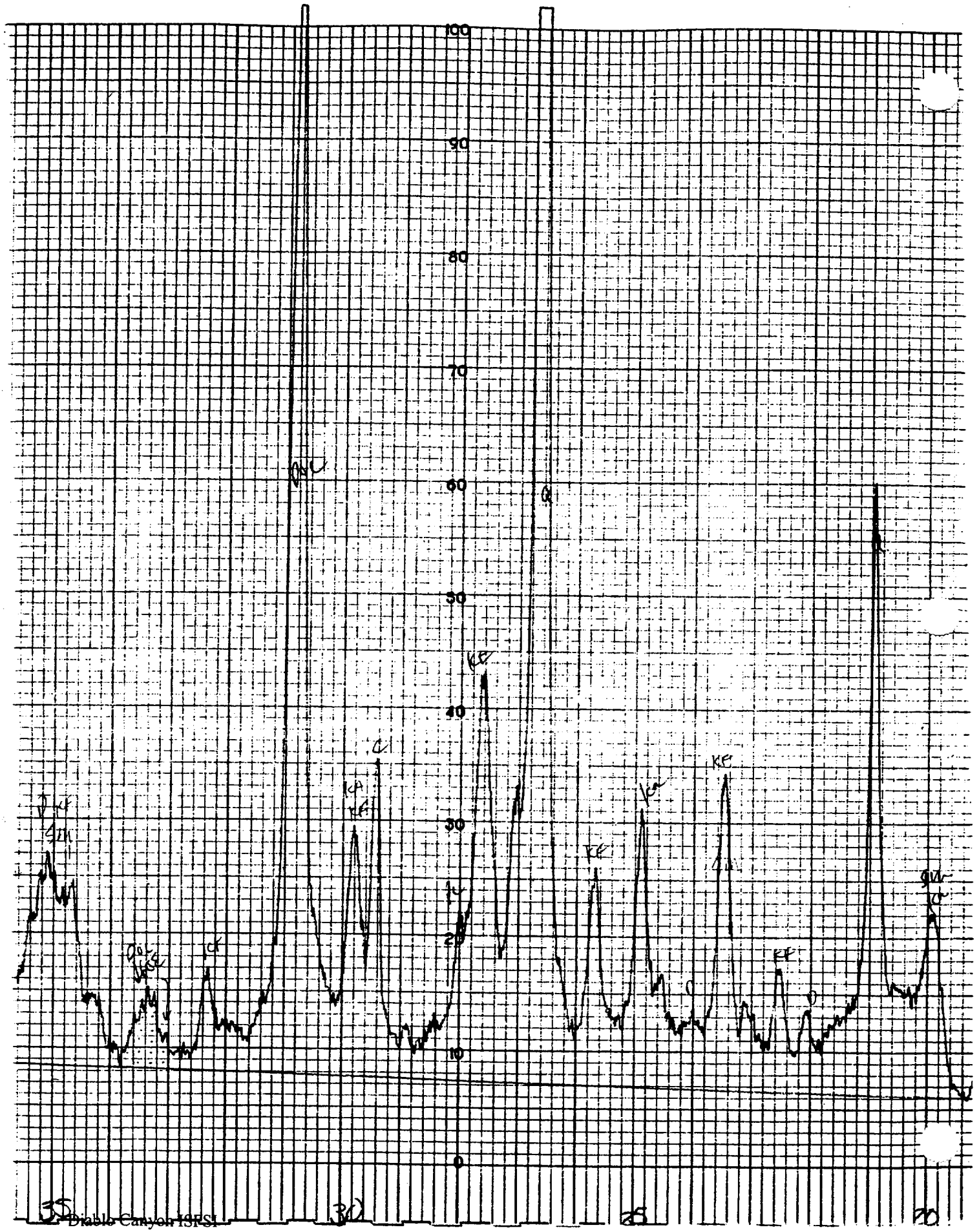
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK

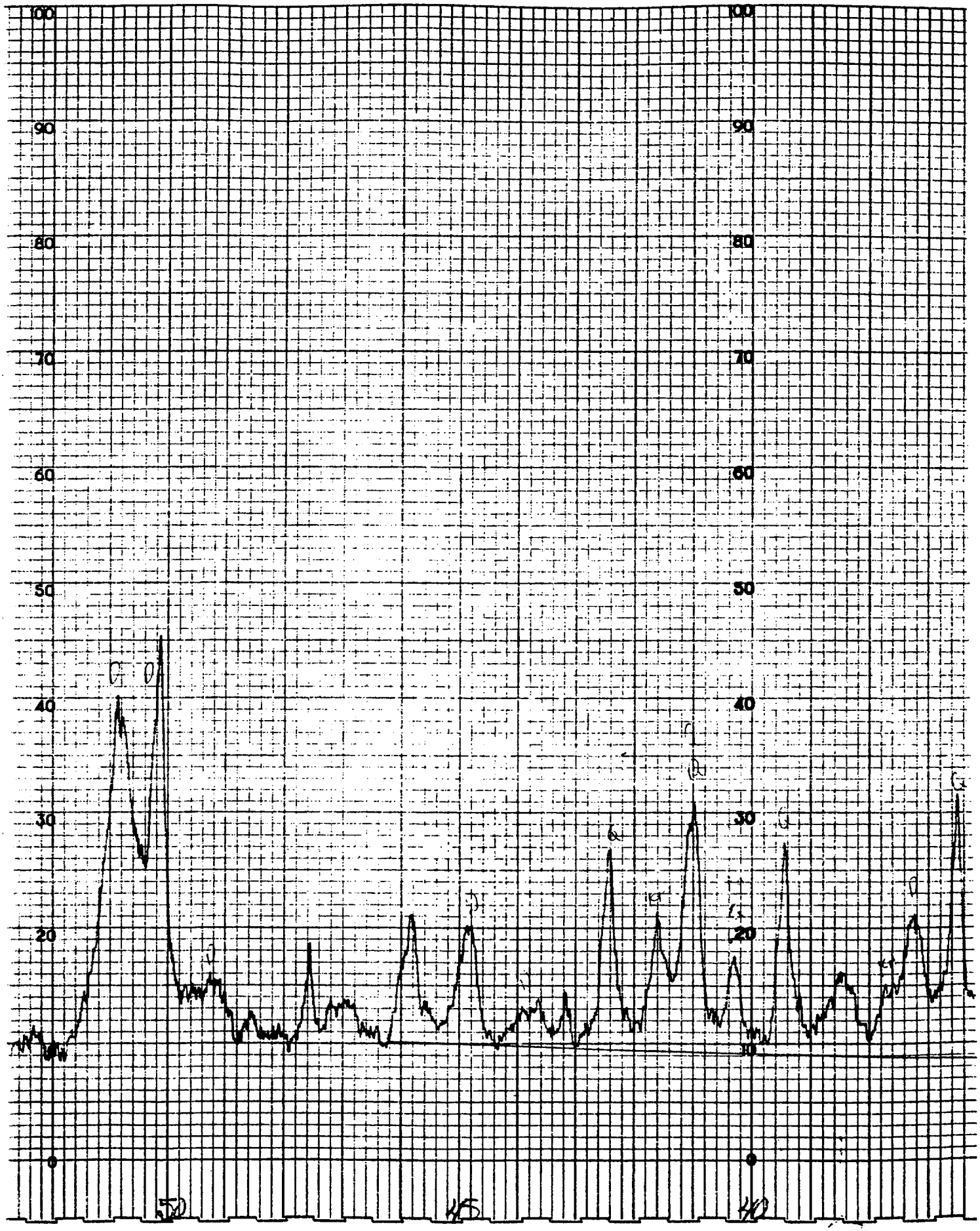

100
90
80
70
60
50
40
30
20
10
0
24
30
NO. BR R0790

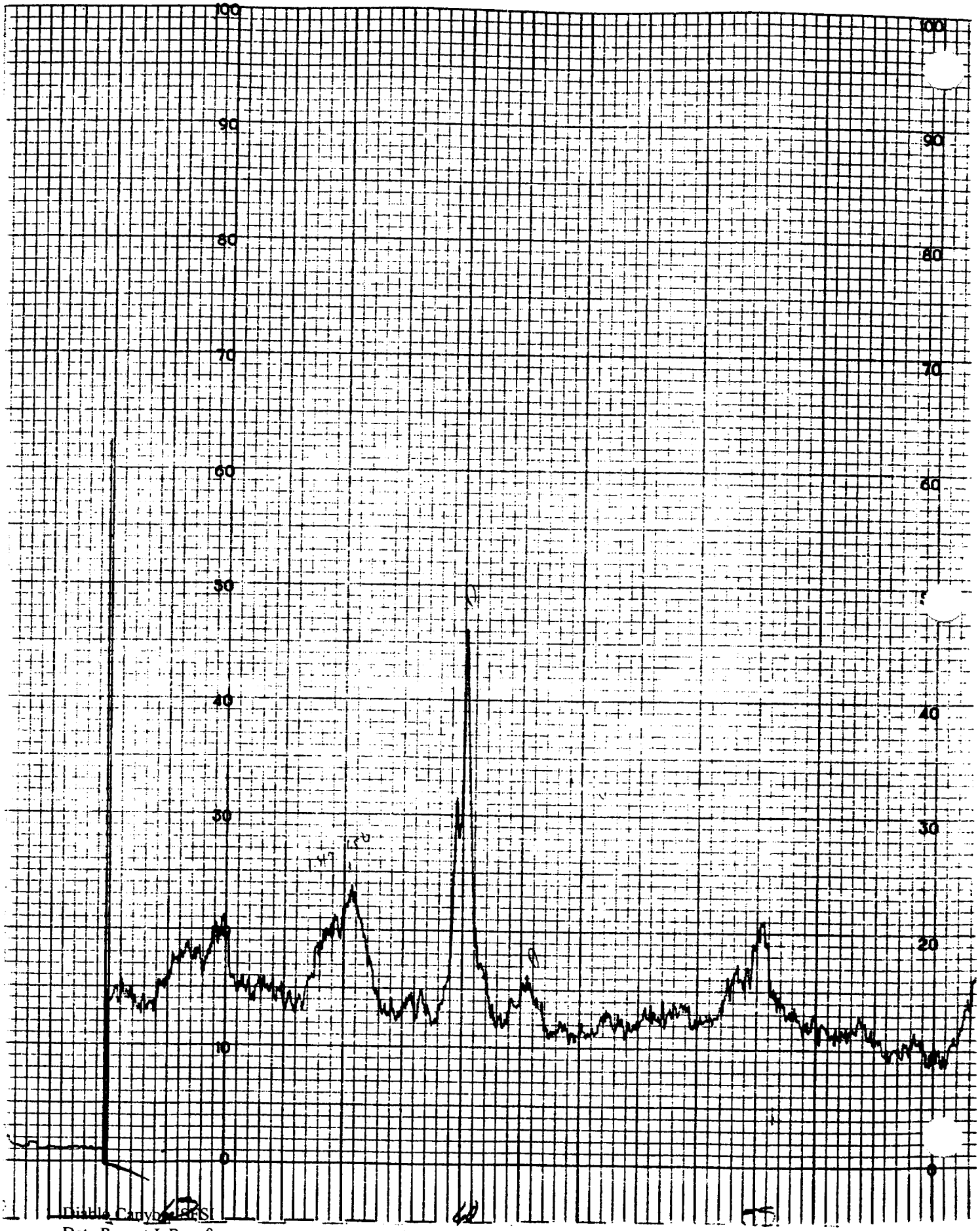

100
90
80
70
60
50
40
30
20
10
0
SPECTRUM PETROGRAPHICS
P-11
Bulk Glycol

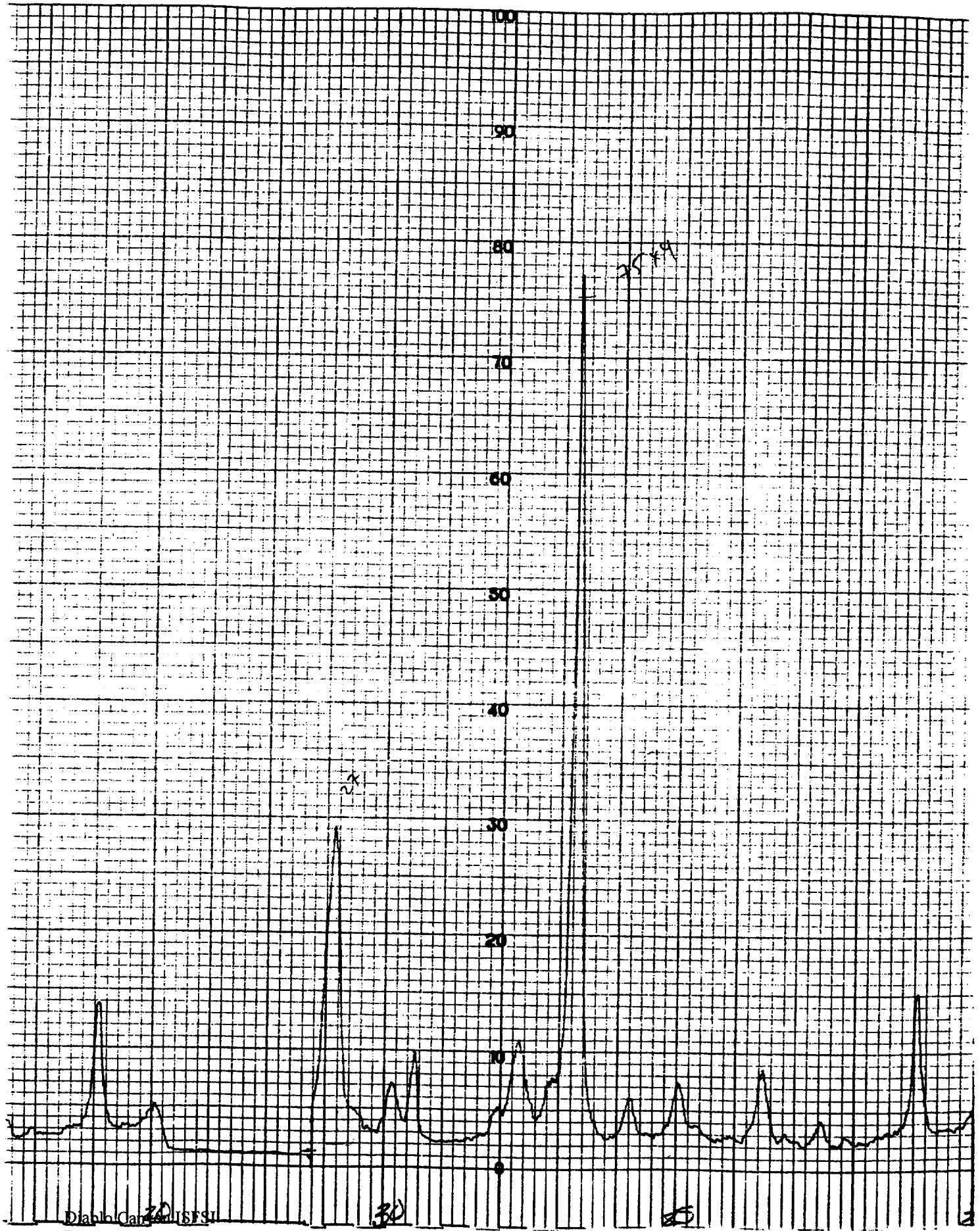

100
90
80
70
60
50
40
30
20
10
0
SPECTRUM PETROGRAPHICS
Bulk
Q - 16
Pl - 3
KF - 9
C - 4
Poc - 15
Goe - 2
KA - 9
Sum - 43 = 42
100
pretty orange

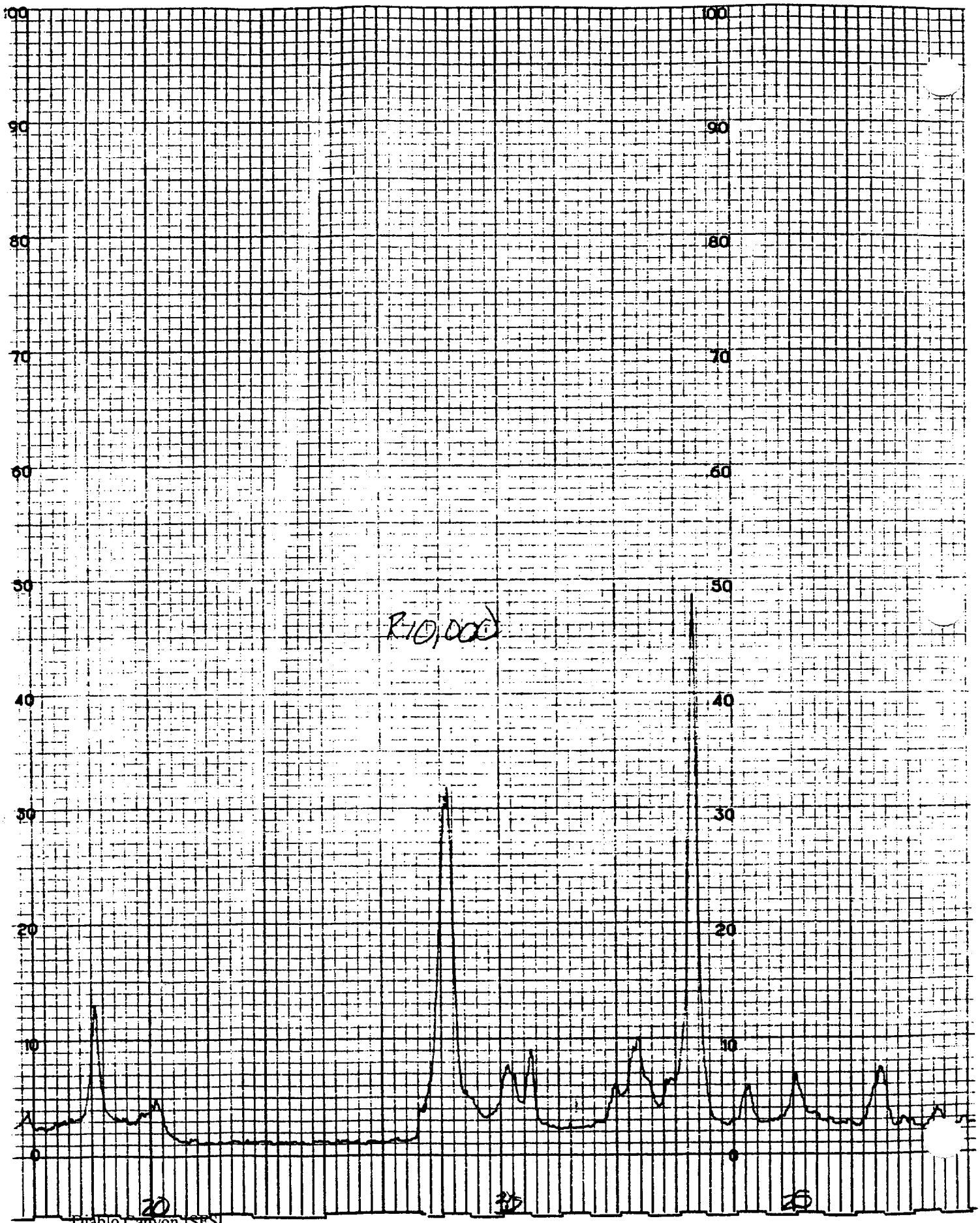

100
90
80
70
60
50
40
30
20
10
0

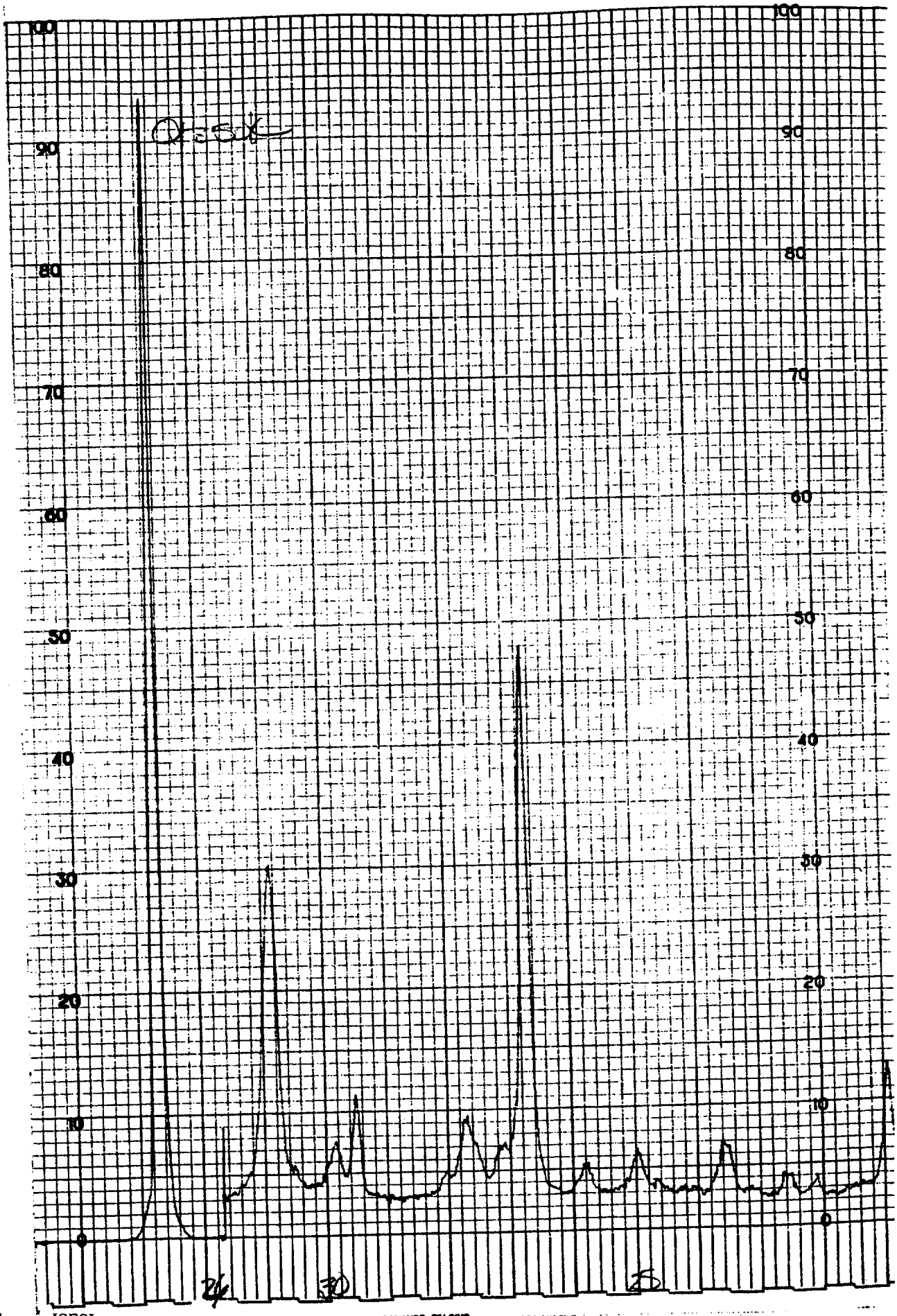

100
90
80
70
60
50
40
30
20
10
0
35
30
25
20

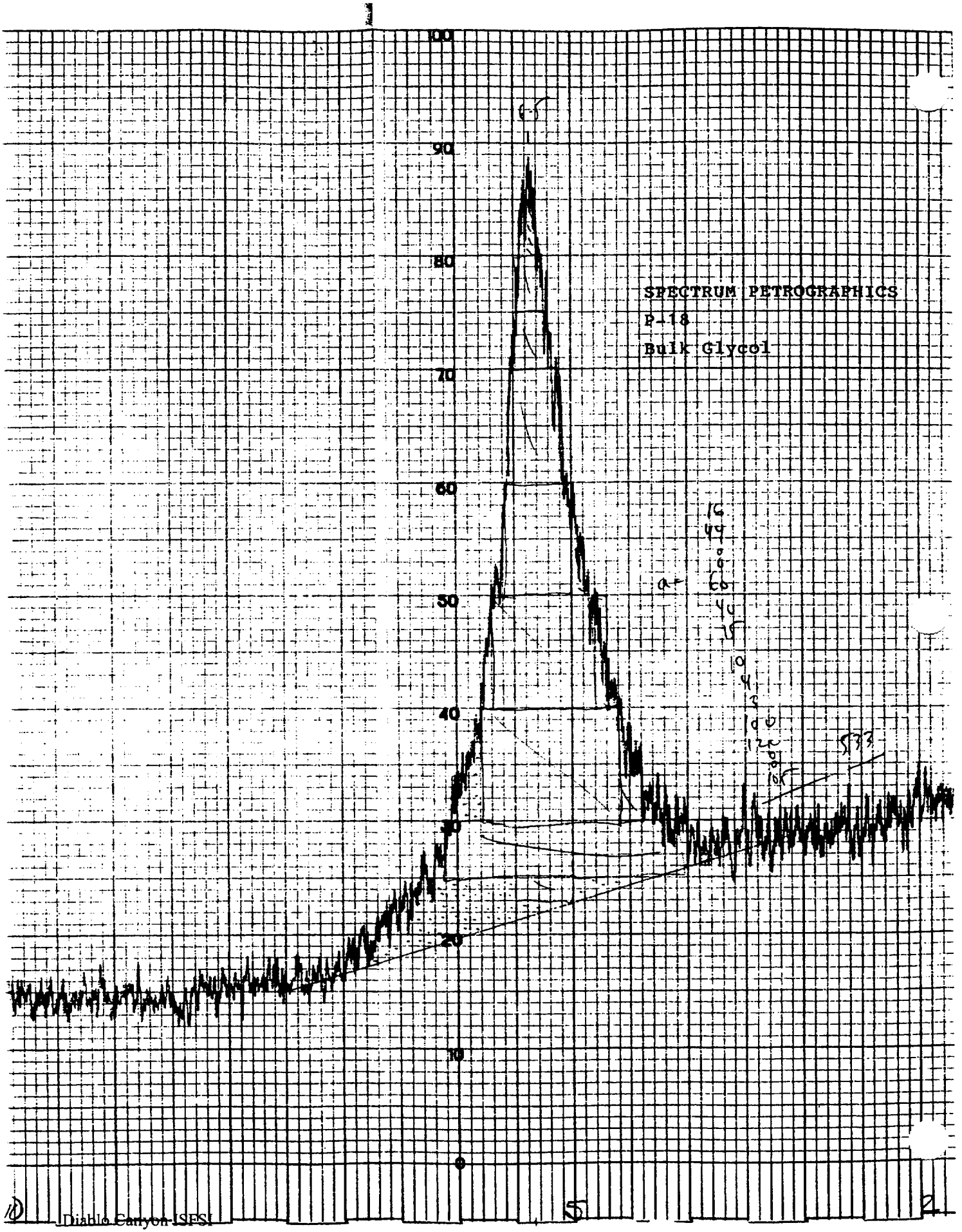

100
90
80
70
60
50
40
30
20
10
0
50
45
40

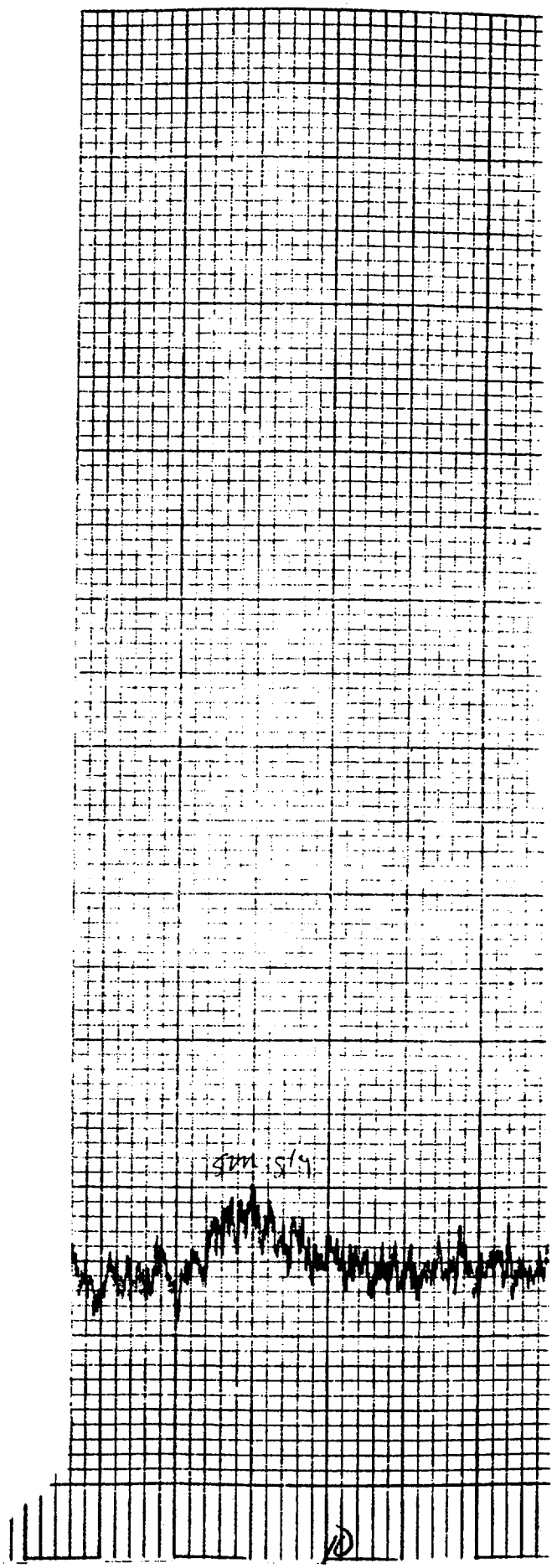

100
90
80
70
60
50
40
30
20
10
0

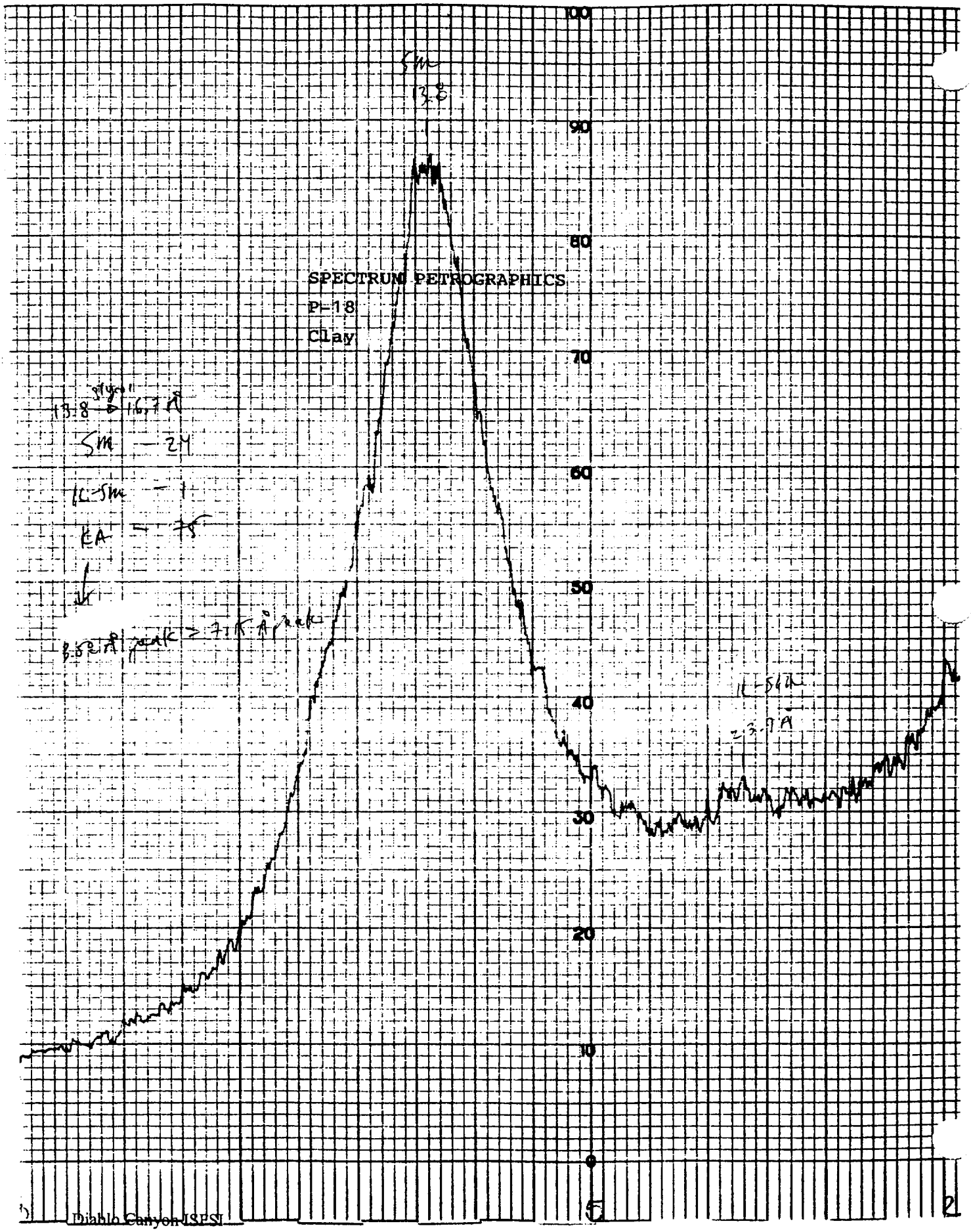

100
90
80
70
60
50
40
30
20
10
0
25+9
27
30
30
35

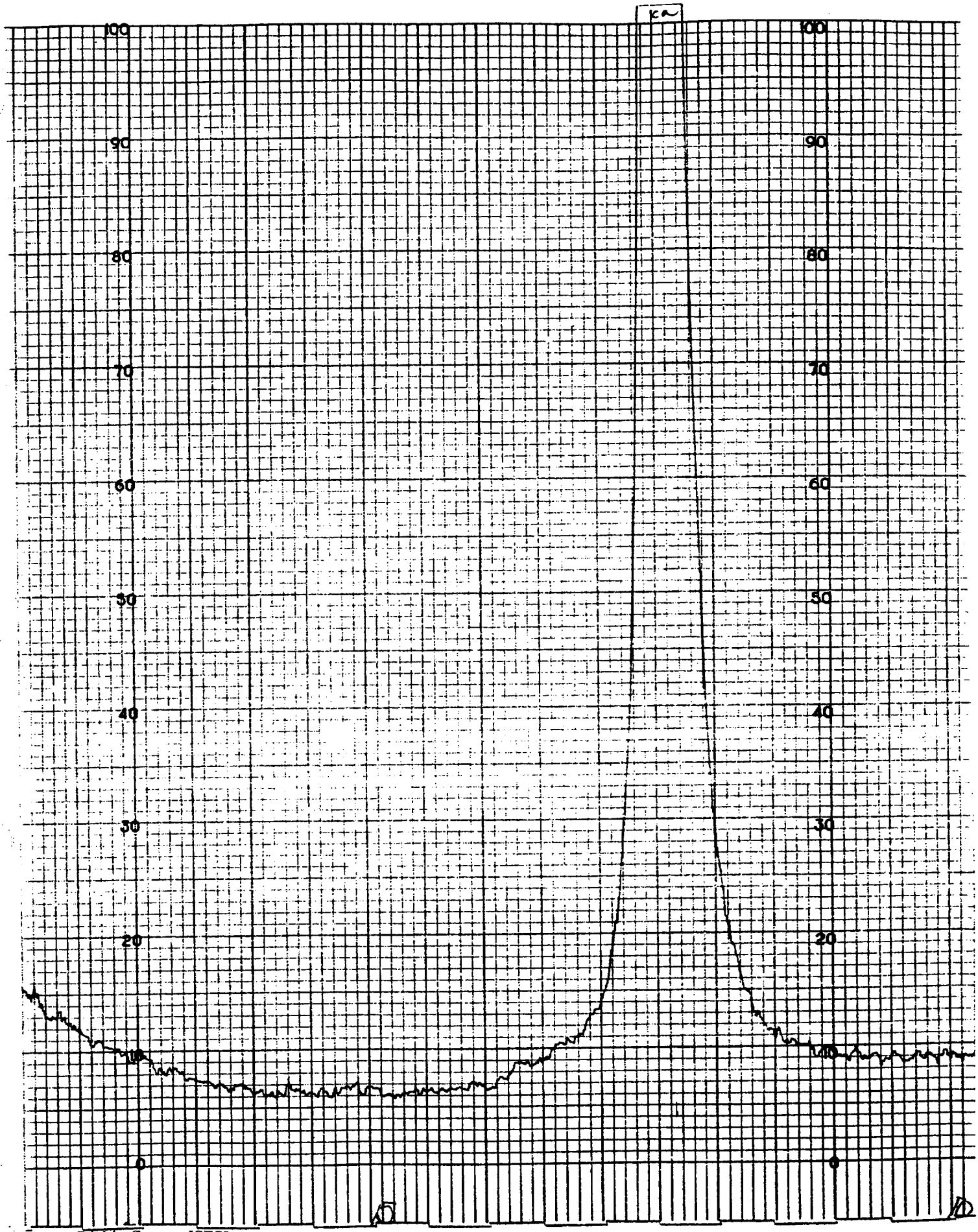

100
90
80
70
60
50
40
30
20
10
0
R10,000
20
35
25

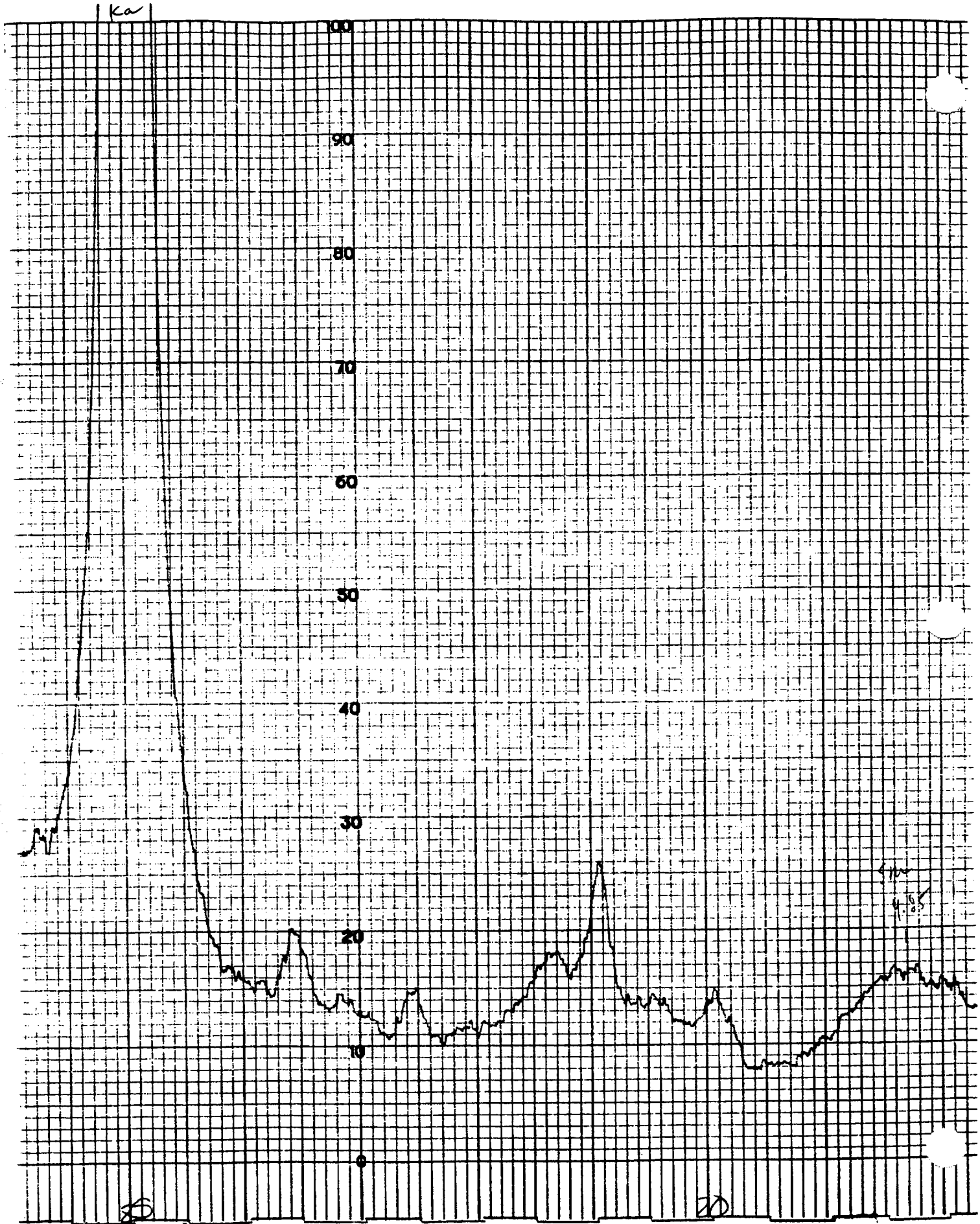

100
90
80
70
60
50
40
30
20
10
0
100
90
80
70
60
50
40
30
20
10
0
25
30
35

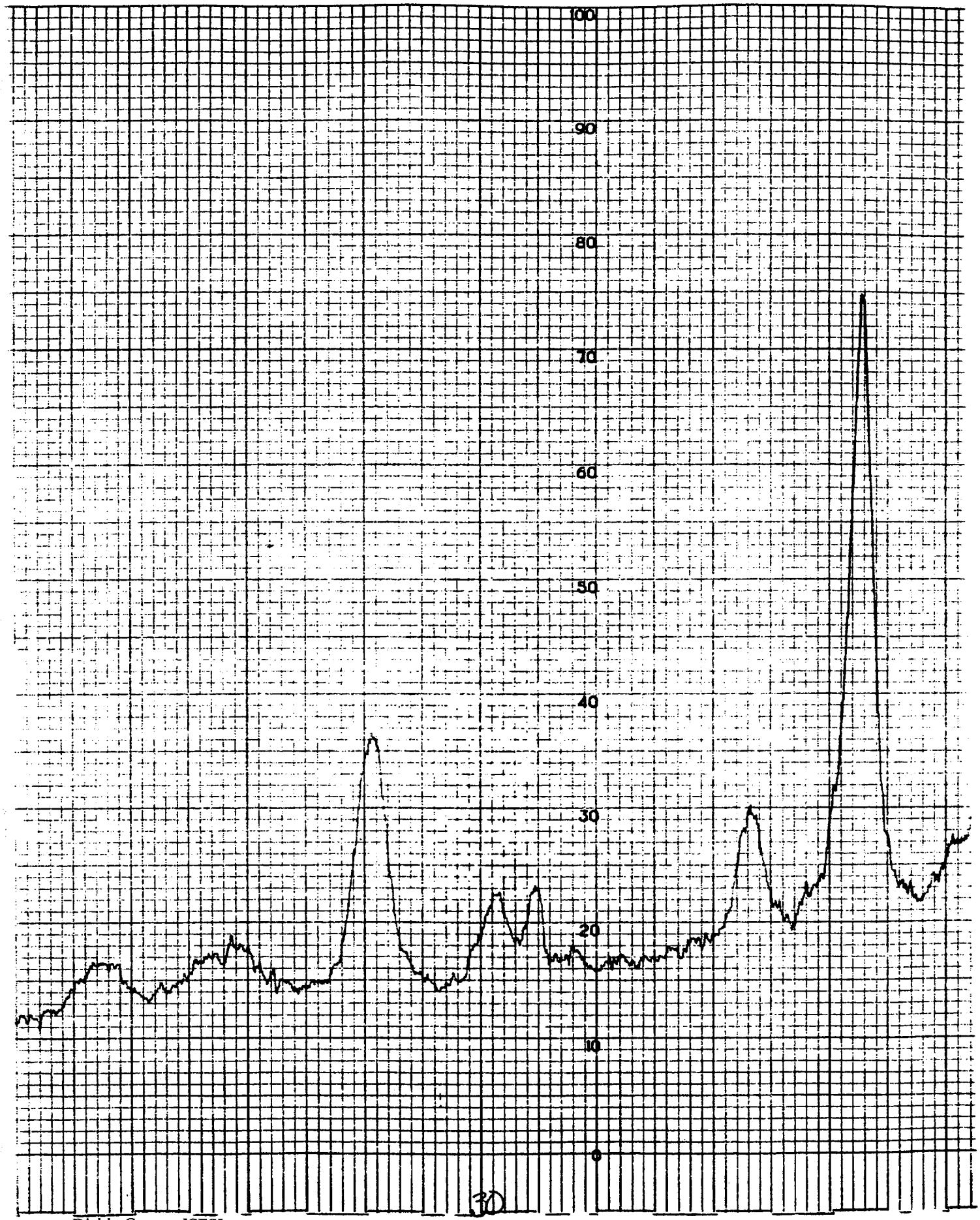

100
90
80
70
60
50
40
30
20
10
0
SPECTRUM PETROGRAPHICS
P-18
Bulk Glycol

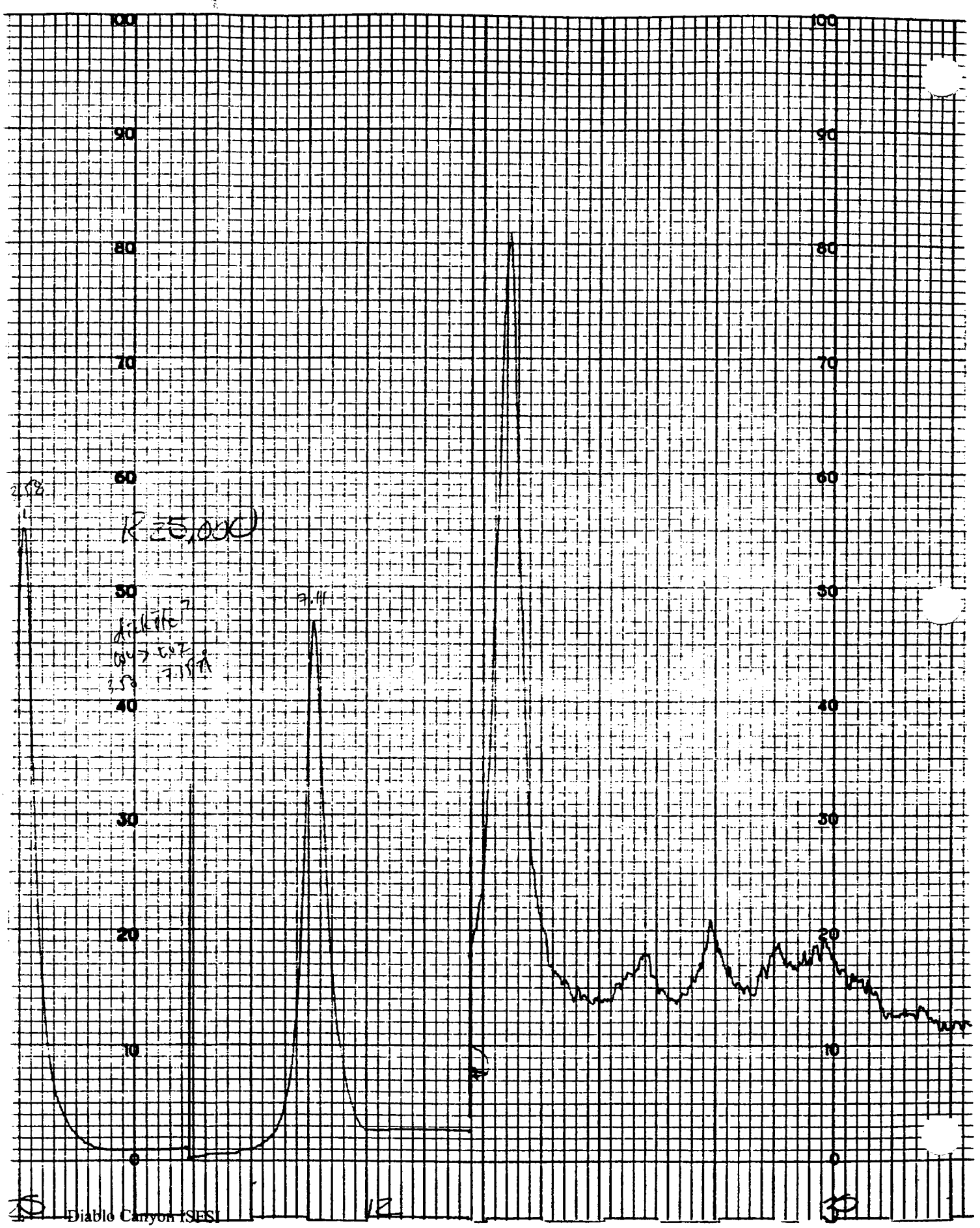

5m 5/9

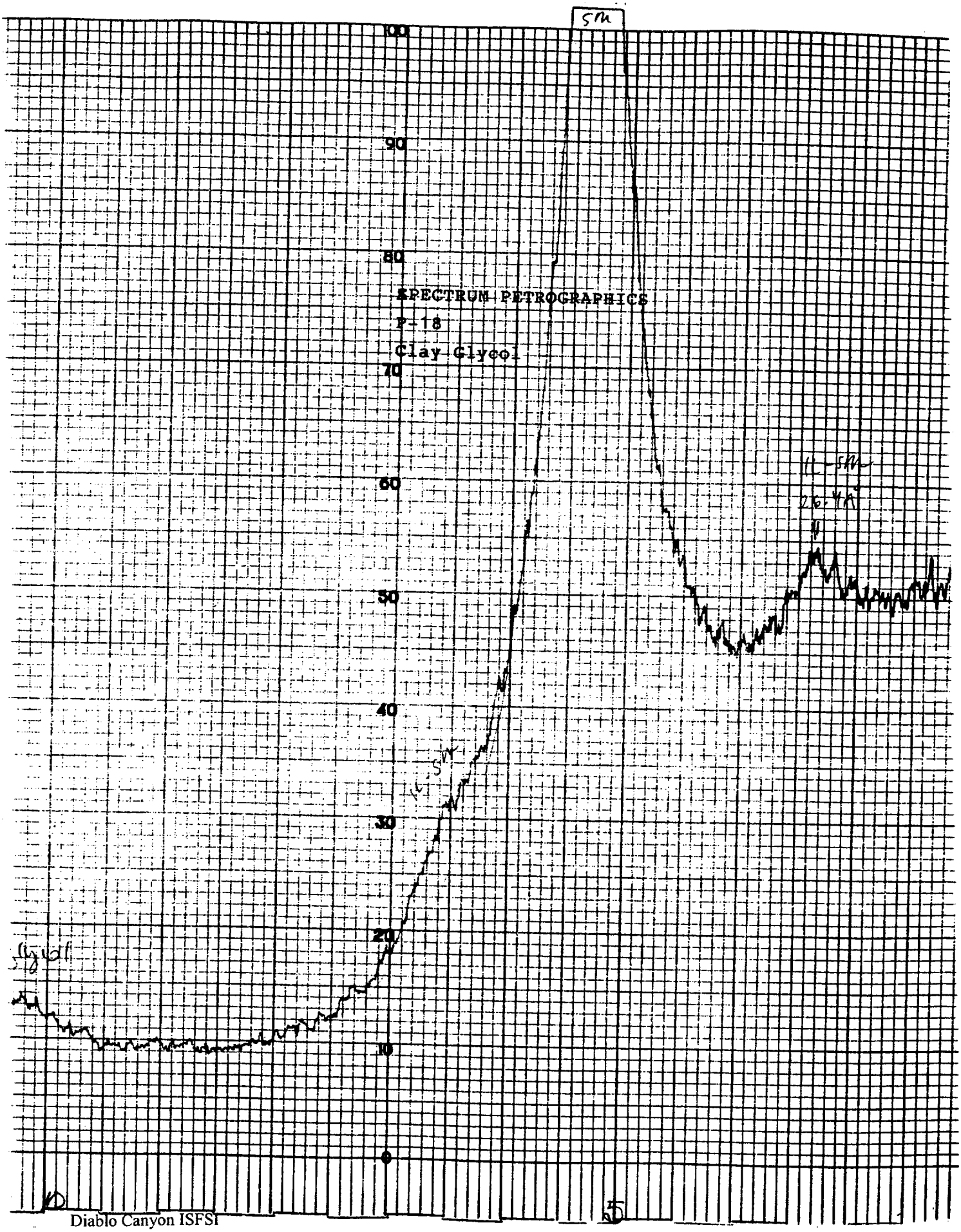

SPECTRUM PETROGRAPHICS
P-18
Clay
100
90
80
70
60
50
40
30
20
10
0
Sm
13.8
13.8 glycol → 16.7 Å
Sm — 24
IL-Sm — 1
KA — 75
8.58 Å peak > 7.15 Å peak
IL-Sm
23.9 Å

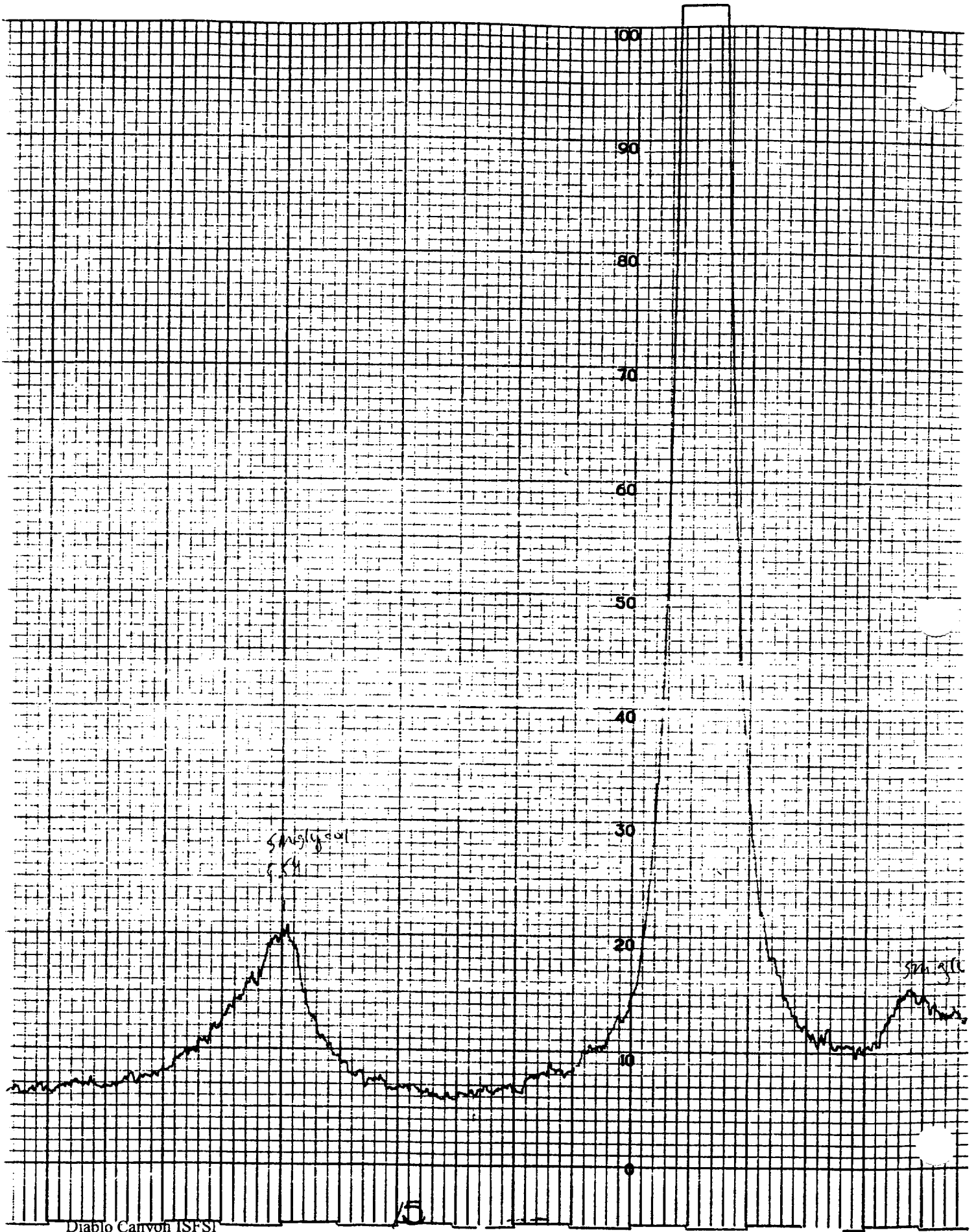

Ka
100
90
80
70
60
50
40
30
20
10
0

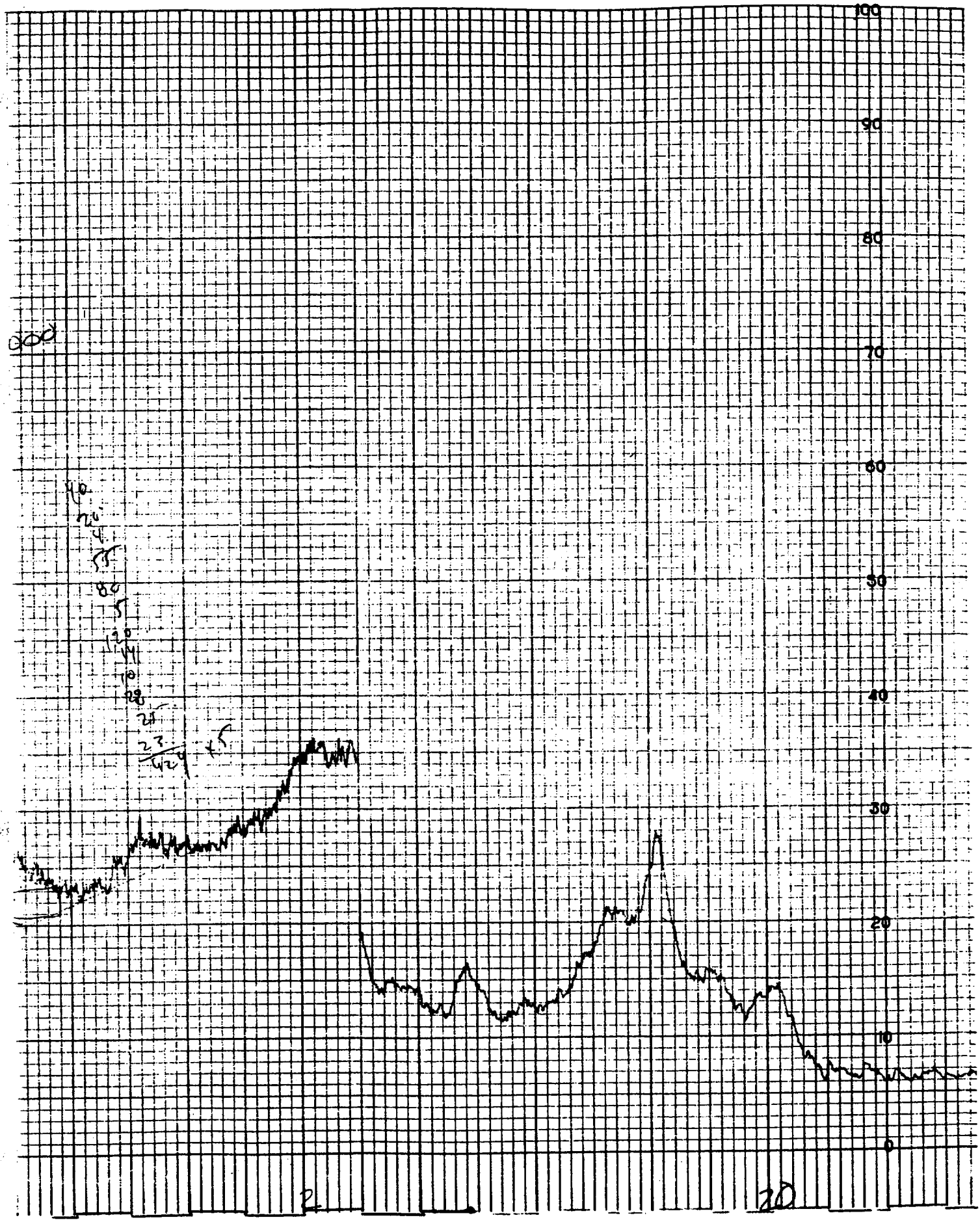

Ka
100
90
80
70
60
50
40
30
20
10
0

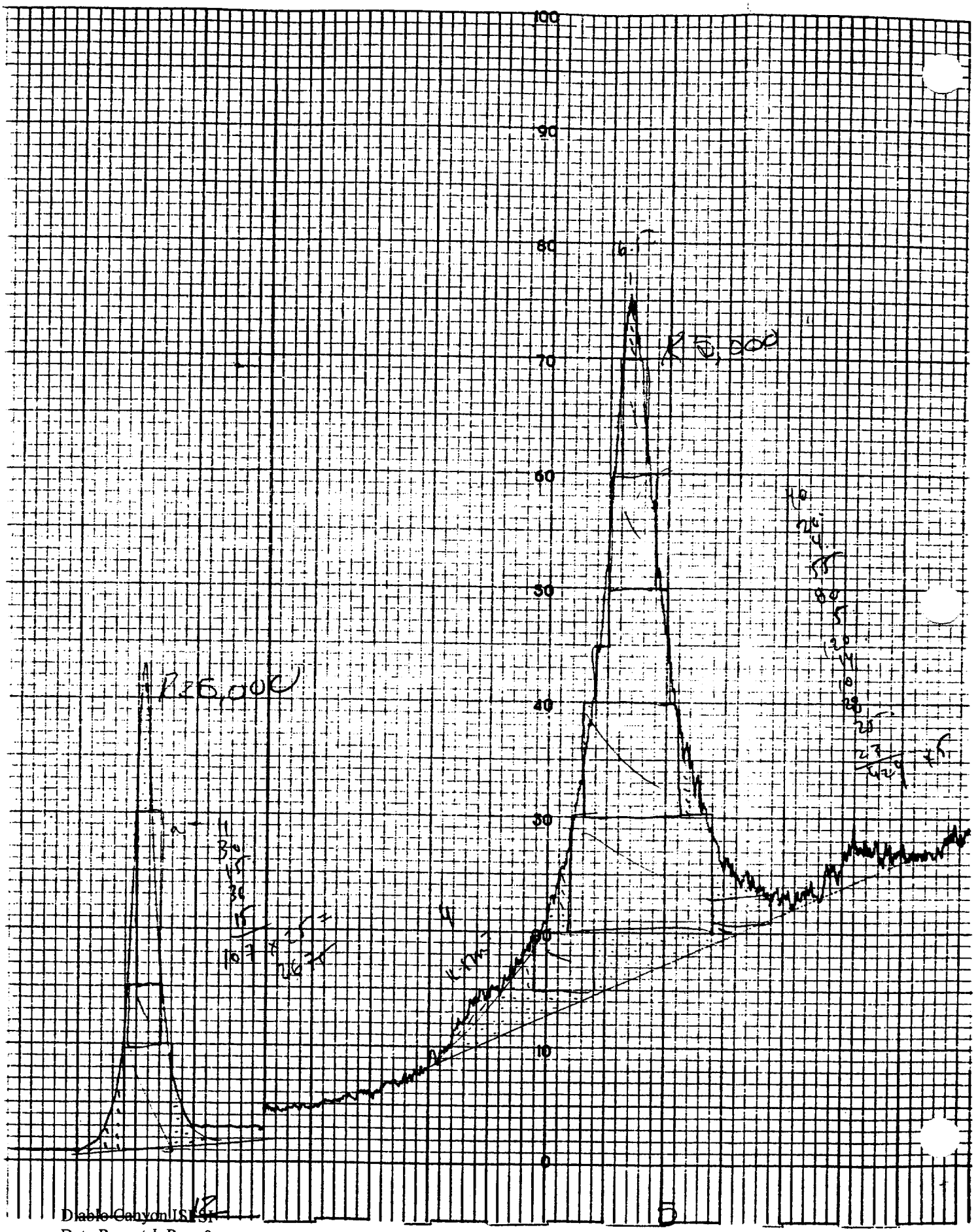

100
90
80
70
60
50
40
30
20
10
0
30


100
90
80
70
60
50
40
30
20
10
0
2.58
R=5,000
7.44

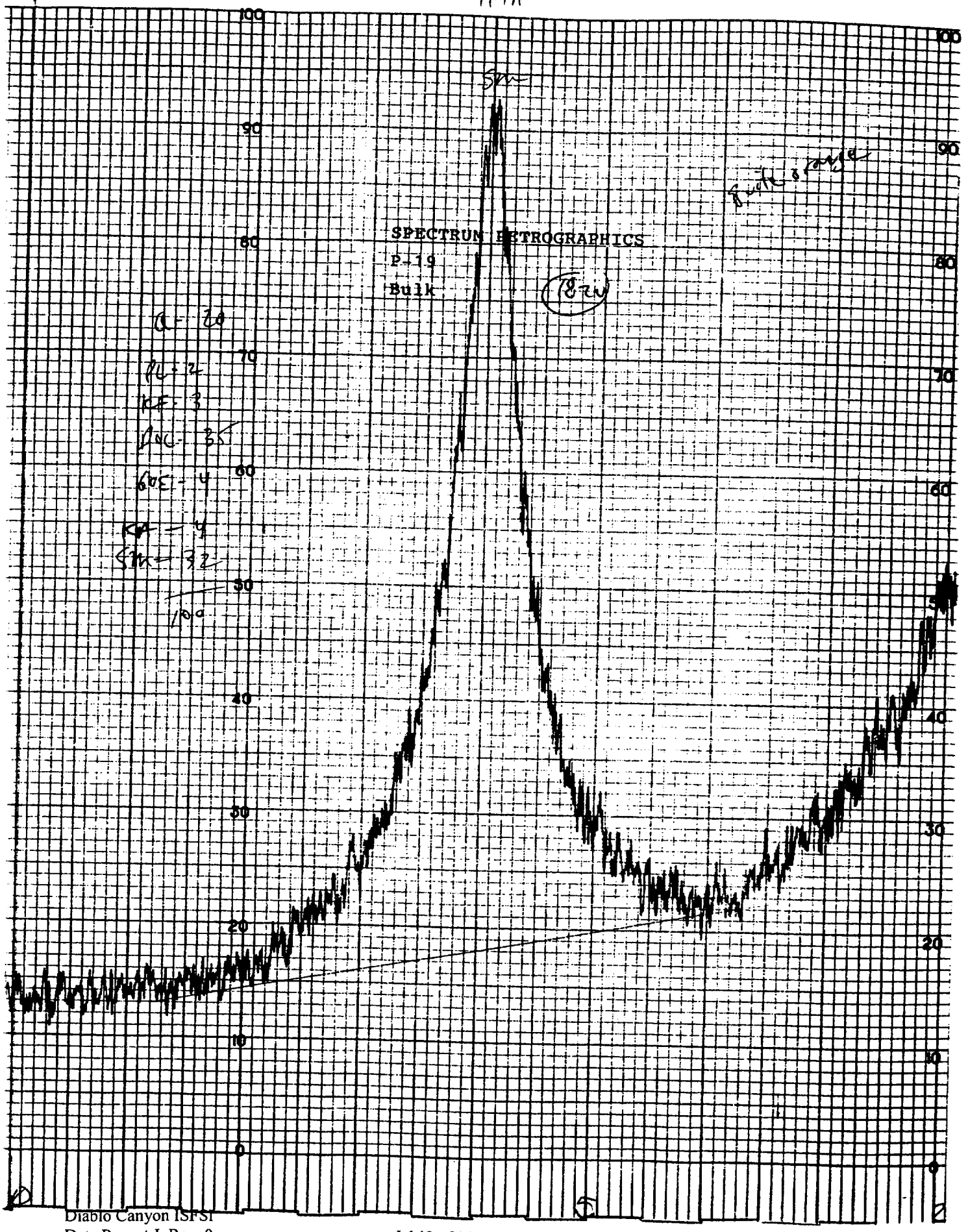

5m
100
90
80
SPECTRUM PETROGRAPHICS
P-18
Clay Glycol
70
60
50
40
30
20
10
0
26.4A
Glycol

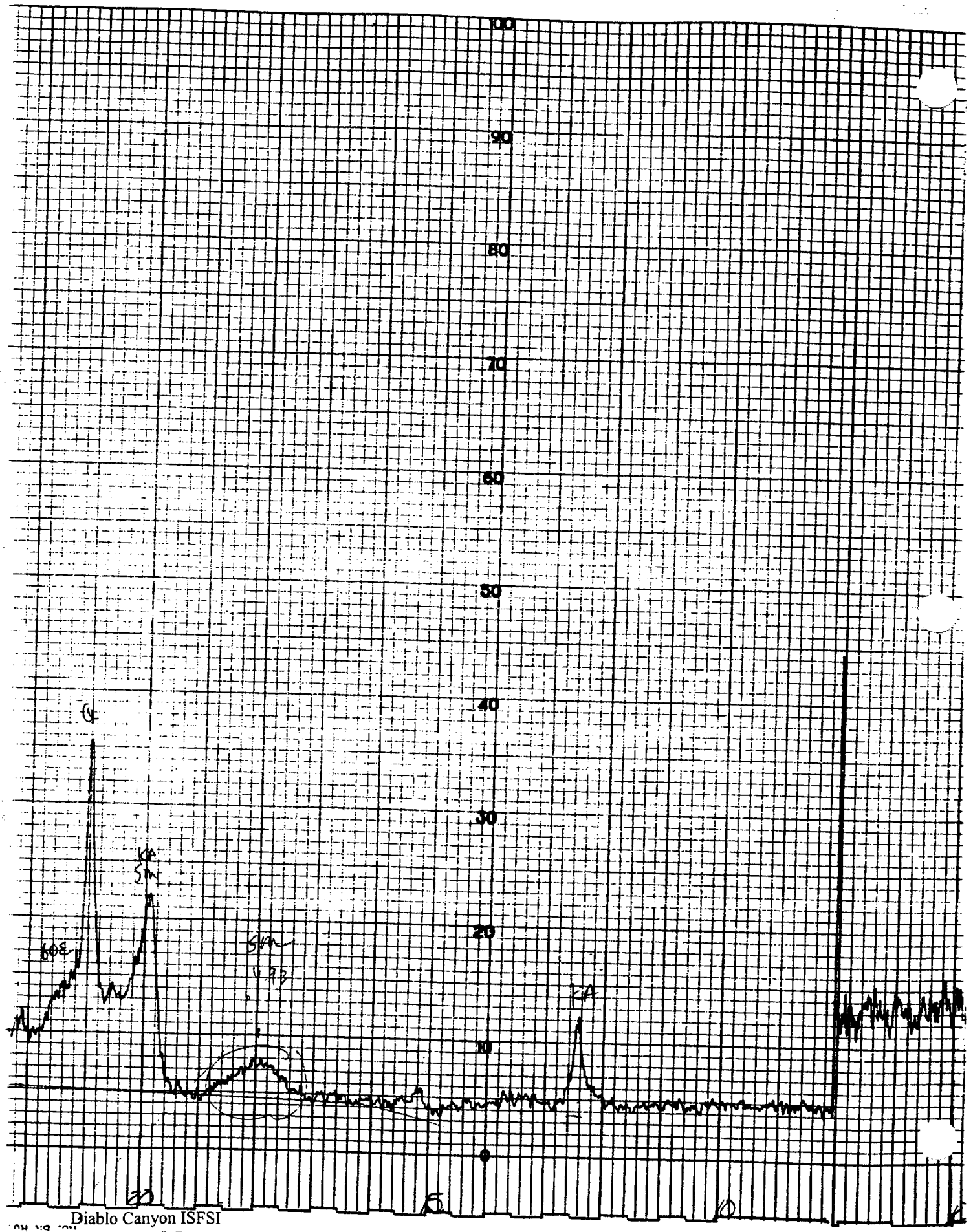

100
90
80
70
60
50
40
30
20
10
0

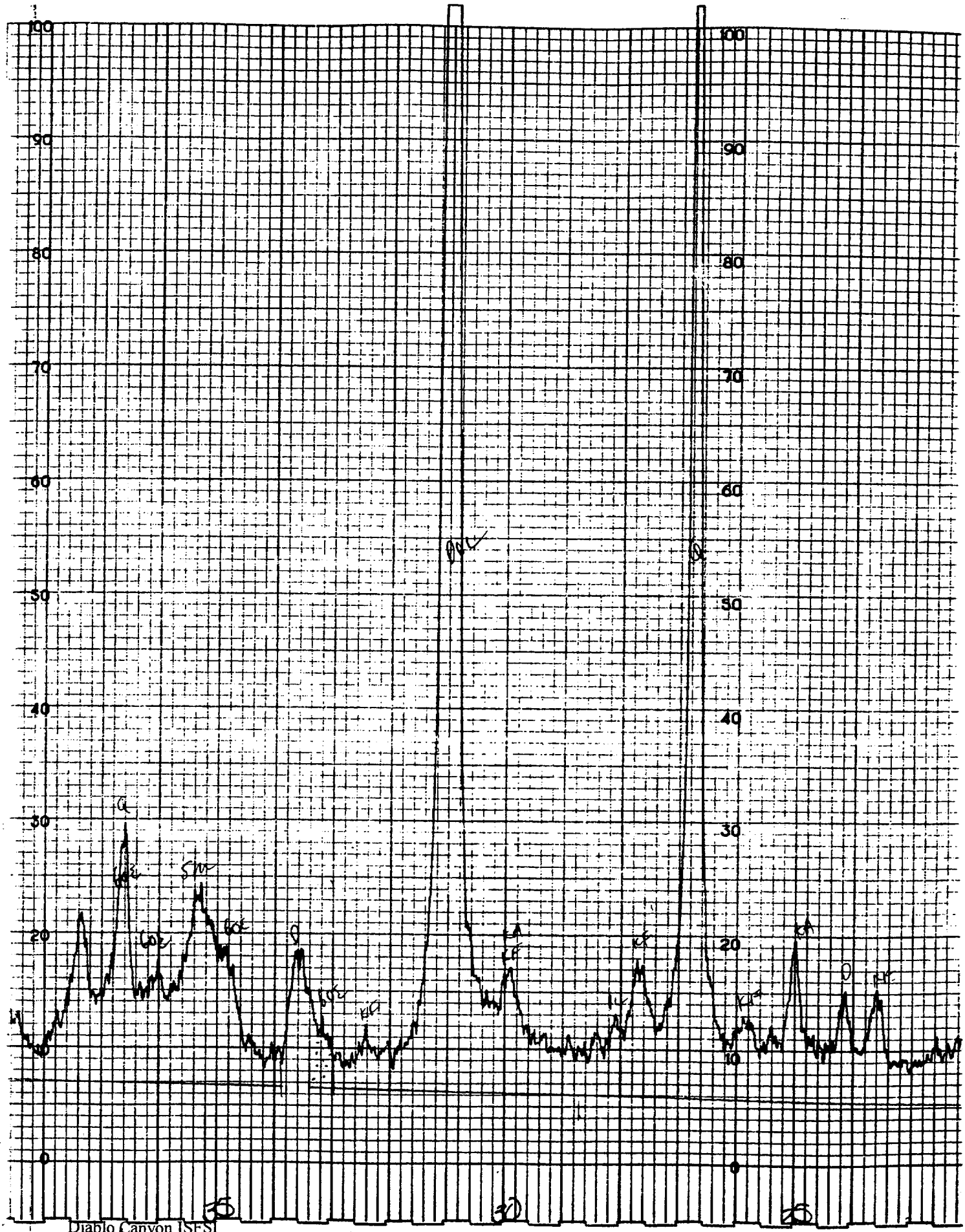

100
90
80
70
60
50
40
30
20
10
0

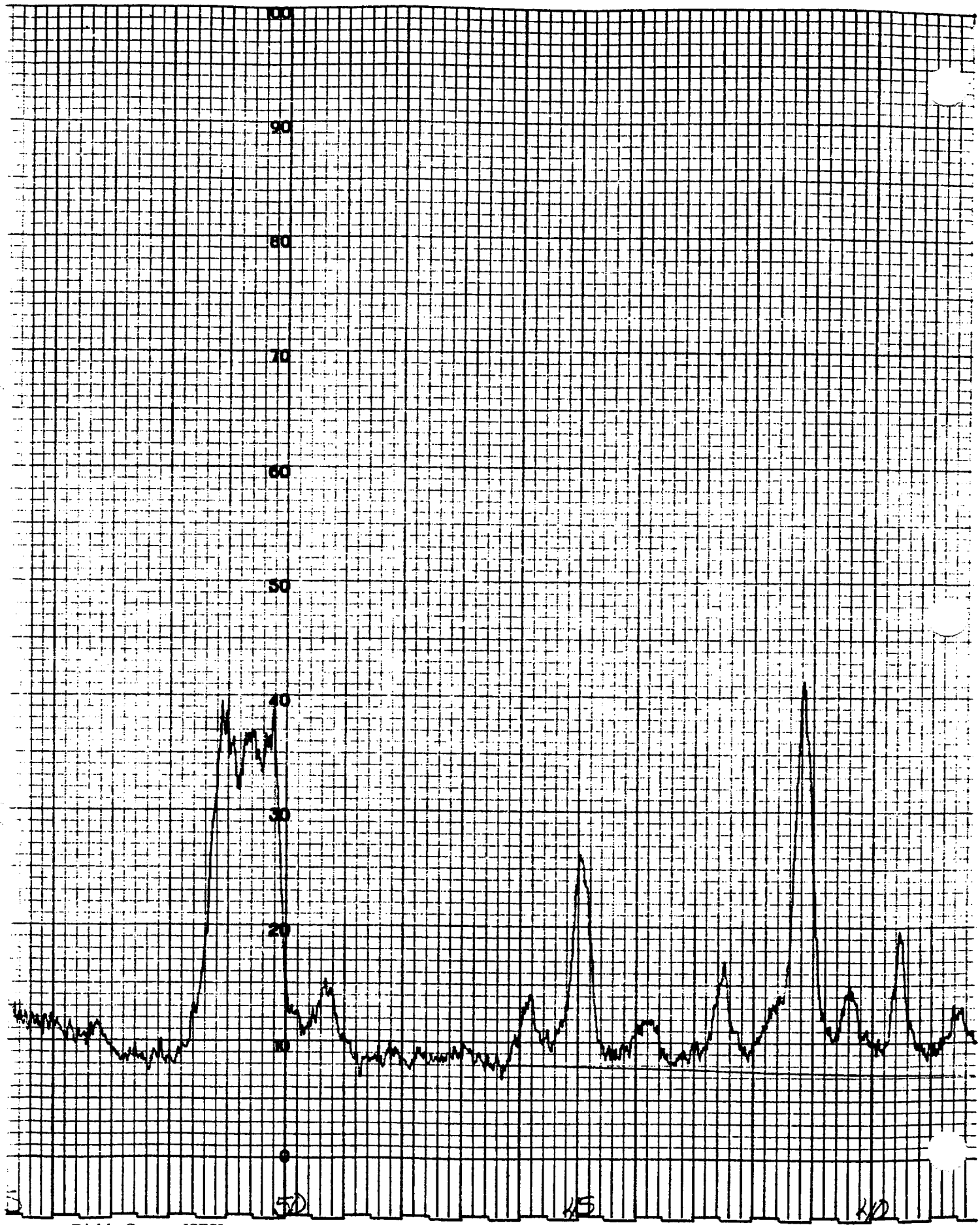

100
90
80
70
60
50
40
30
20
10
0

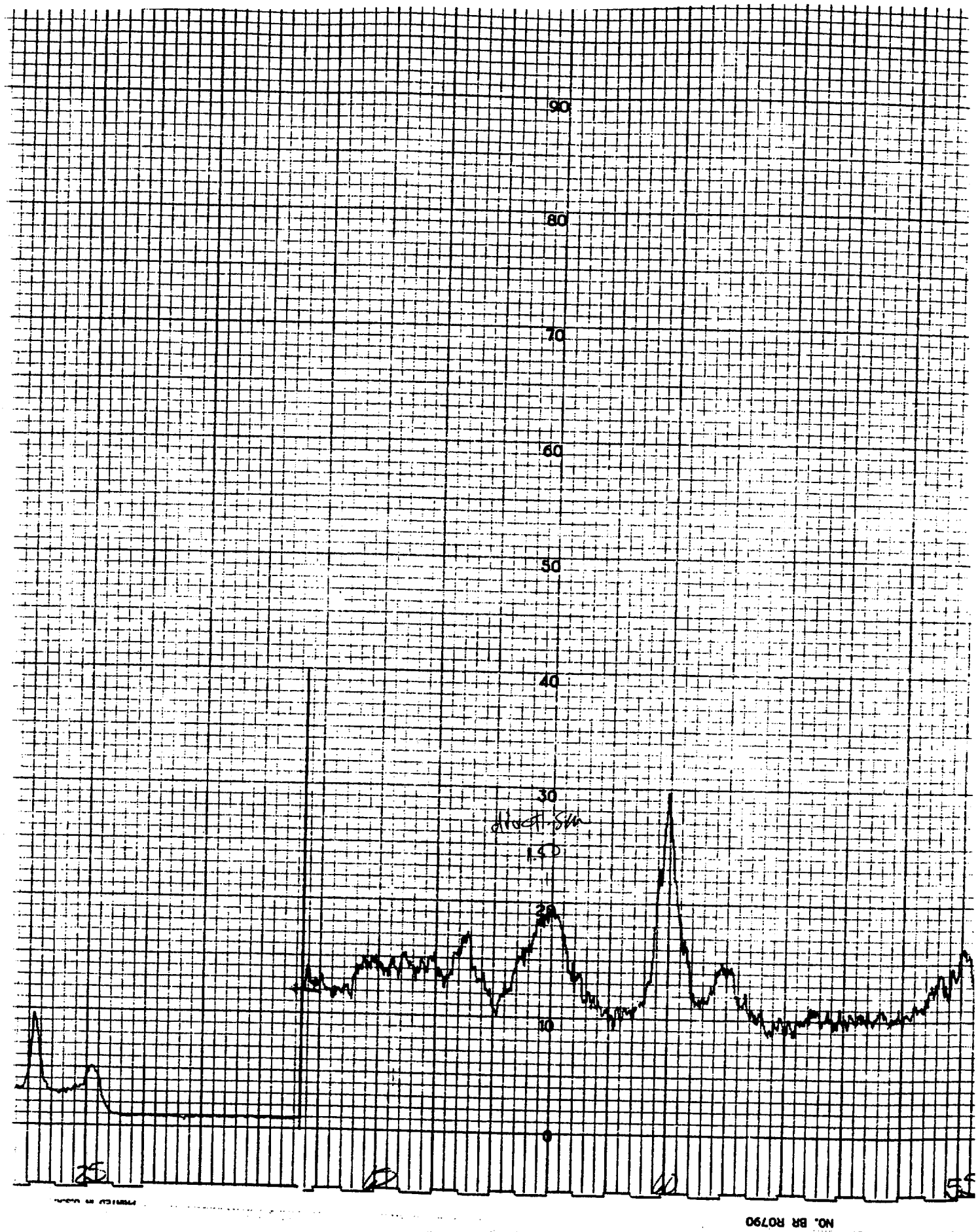
14-7A

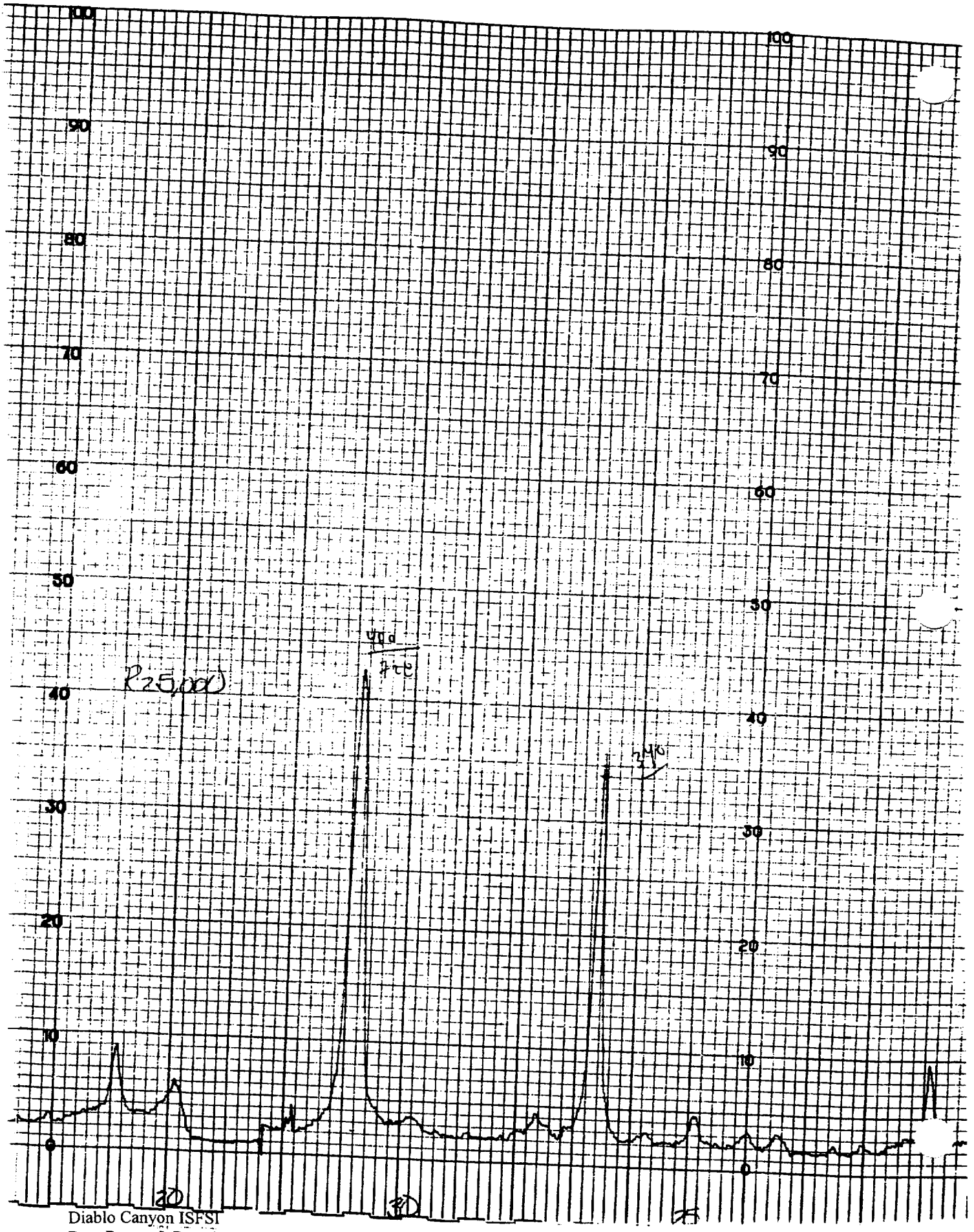

SPECTRUM PETROGRAPHICS
P-19
Bulk
Sm
Eu
Bulk sample
a = 20
Pl = 12
KF = 3
Aug = 35
Gnt = 4
Ka = 4
Sm = 32
100
90
80
70
60
50
40
30
20
10
0

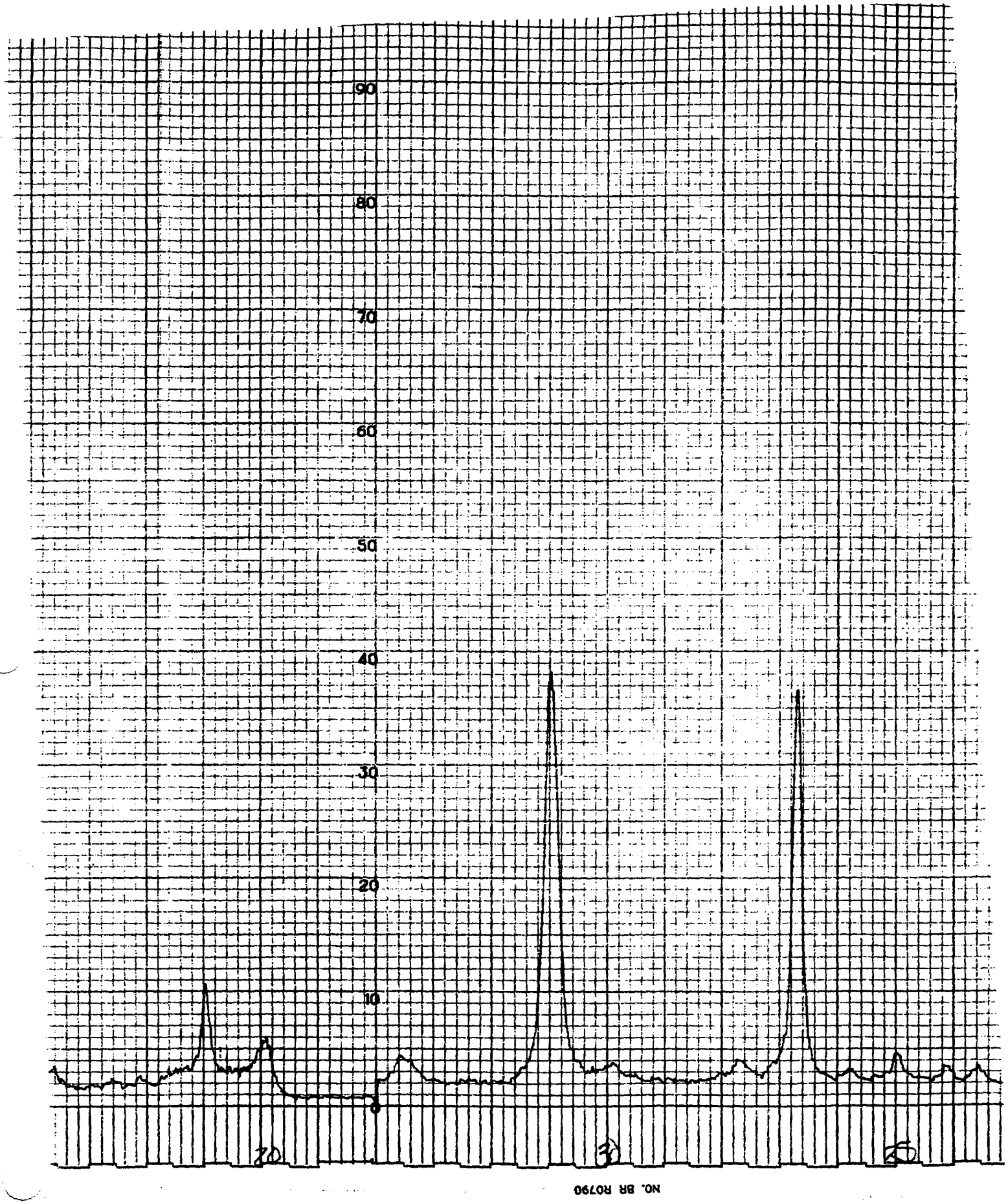

100
90
80
70
60
50
40
30
20
10
0
Cs
Co
Sm
Sm
1.93
Eu
60Co
20
5
10

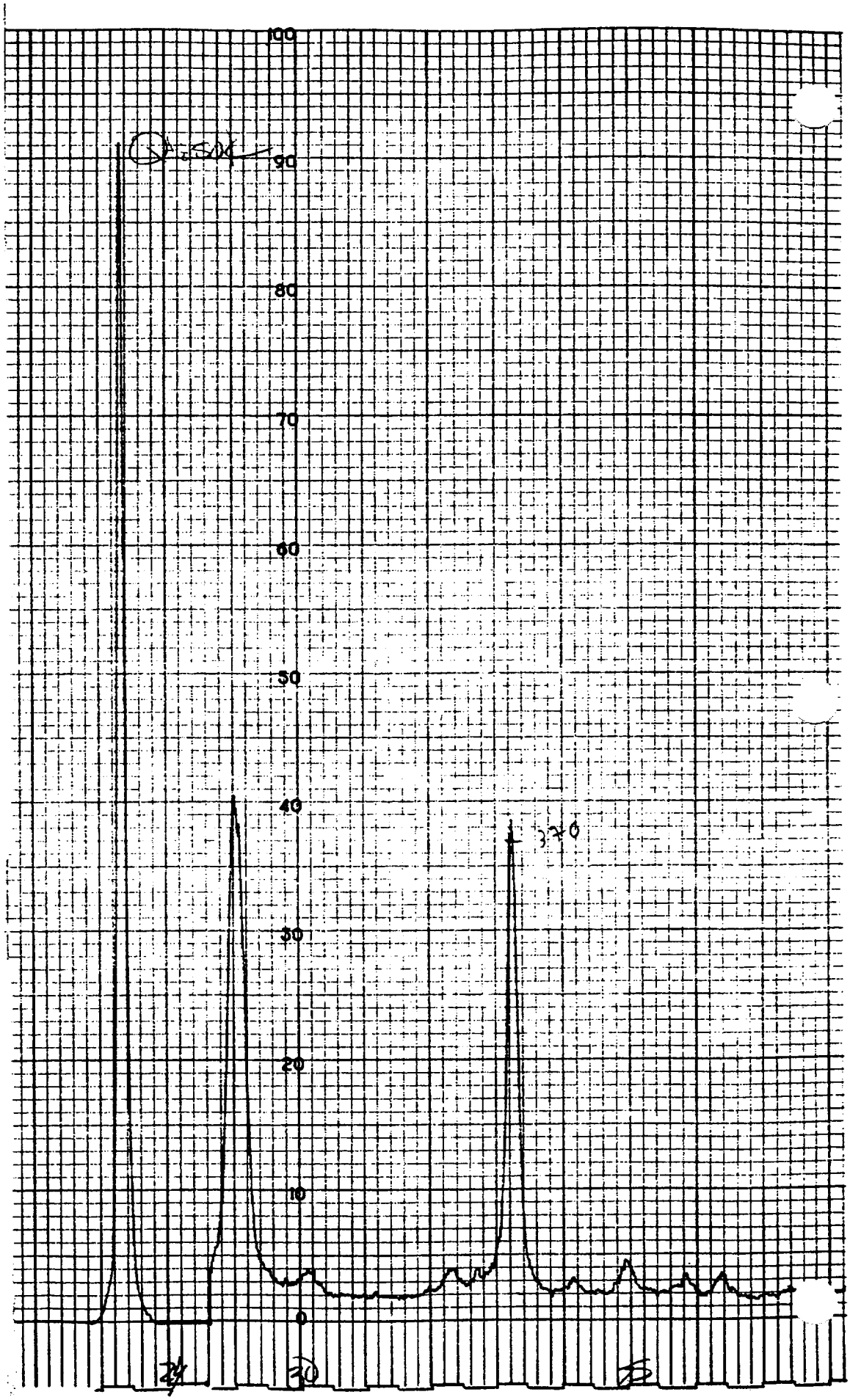

100
90
80
70
60
50
40
30
20
10
0

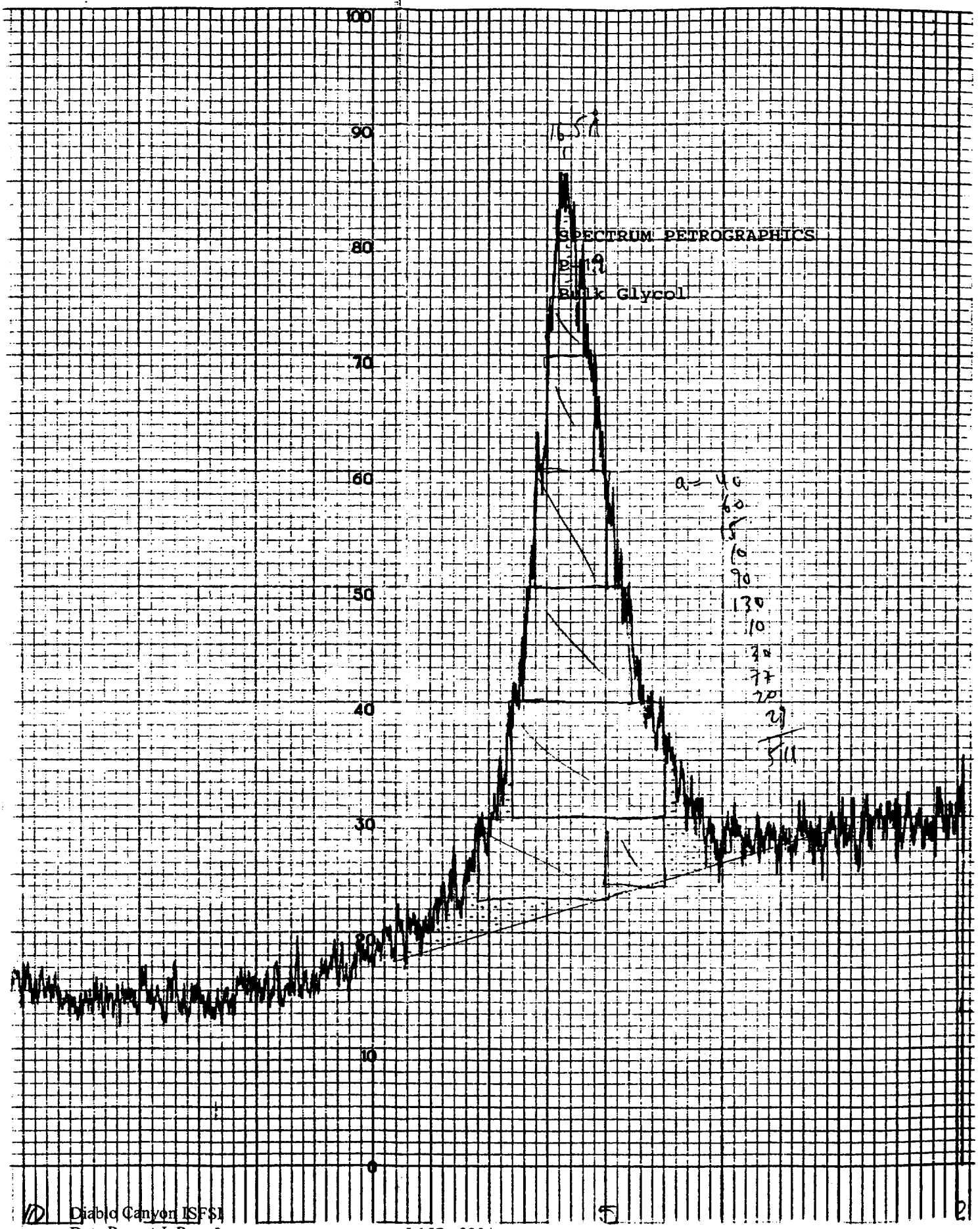

100
90
80
70
60
50
40
30
20
10
0
50
45
40

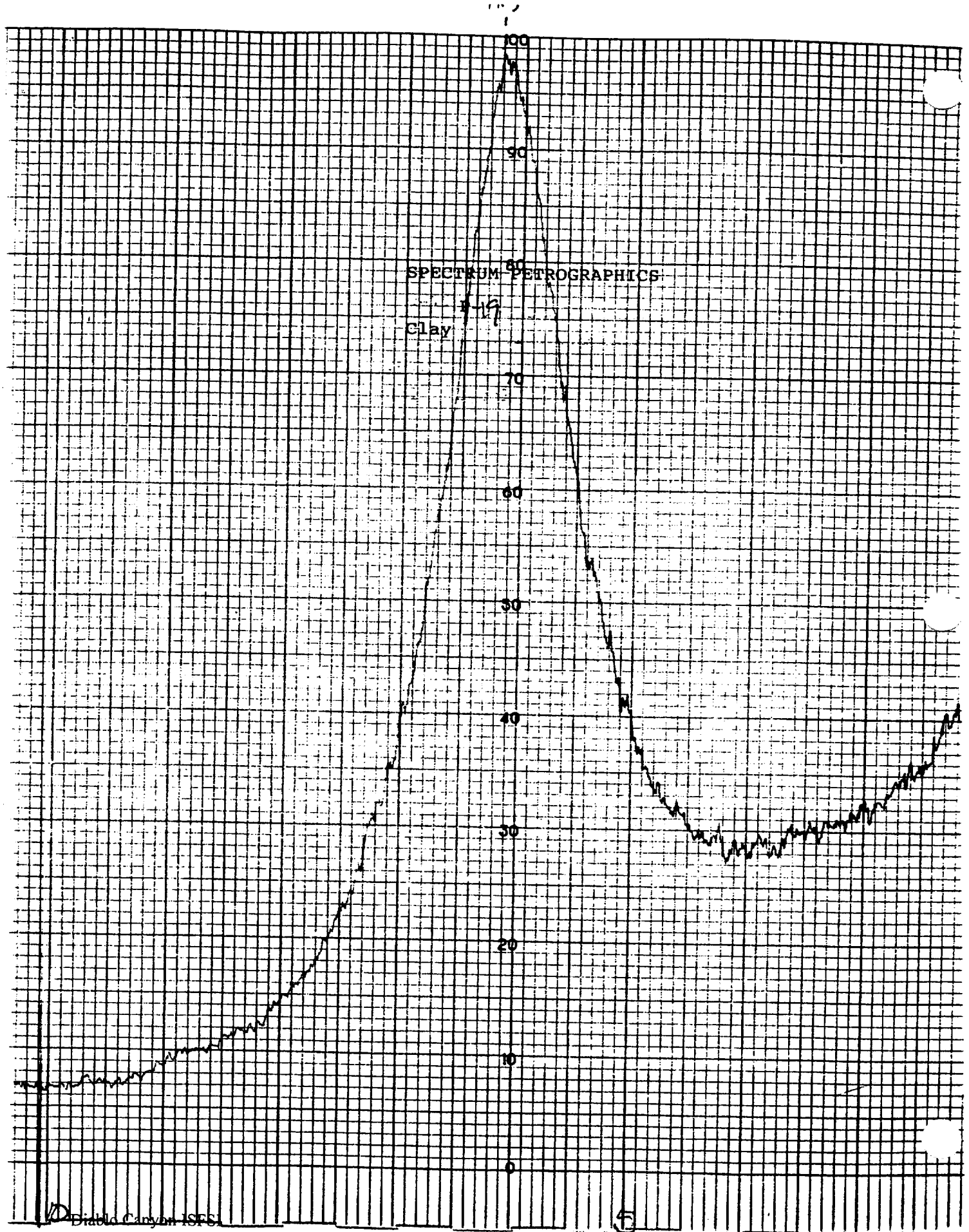

90
80
70
60
50
40
30
20
10
0
NO. BR R0790

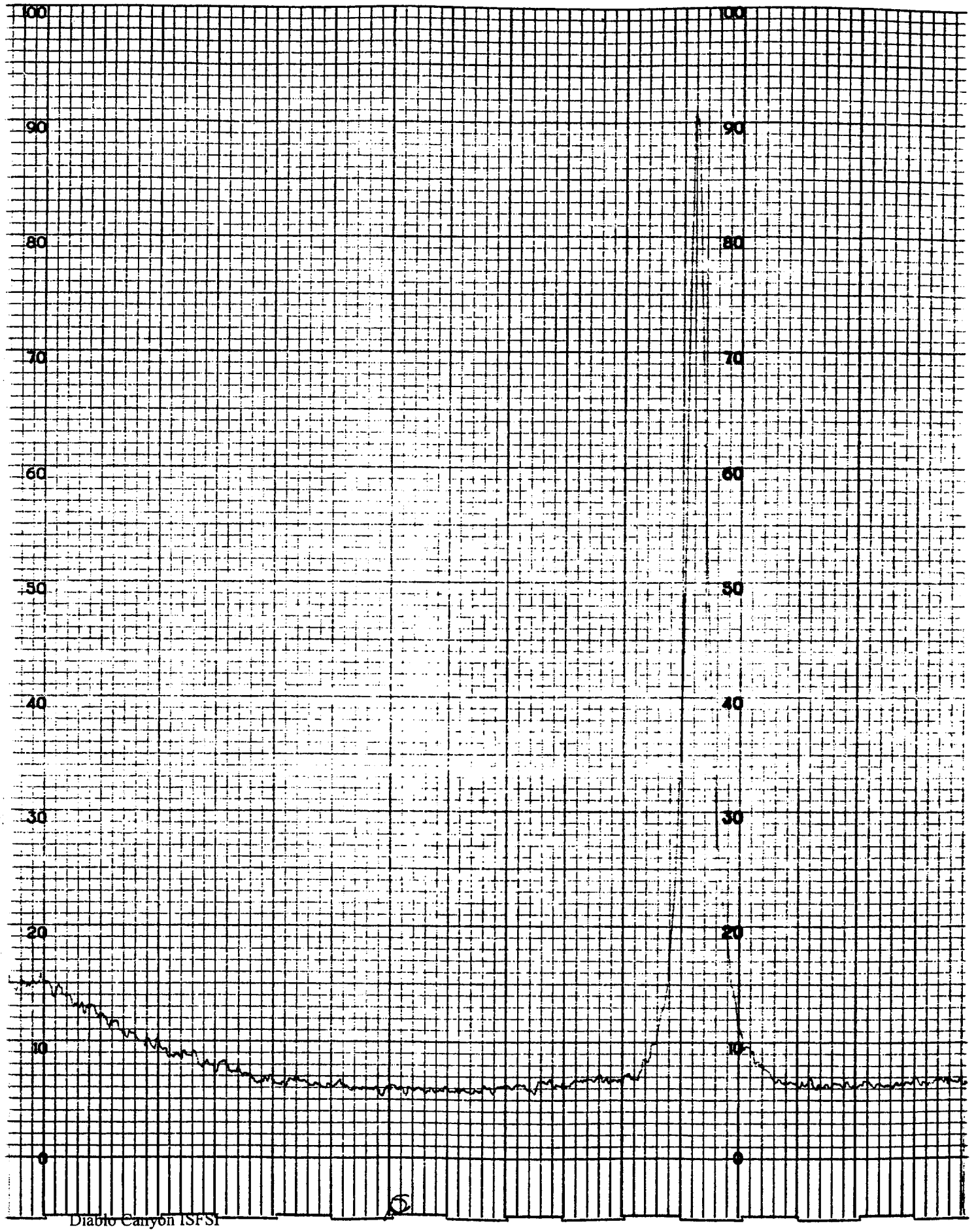

100
90
80
70
60
50
40
30
20
10
0
P25,000
90d
7rt
2MO

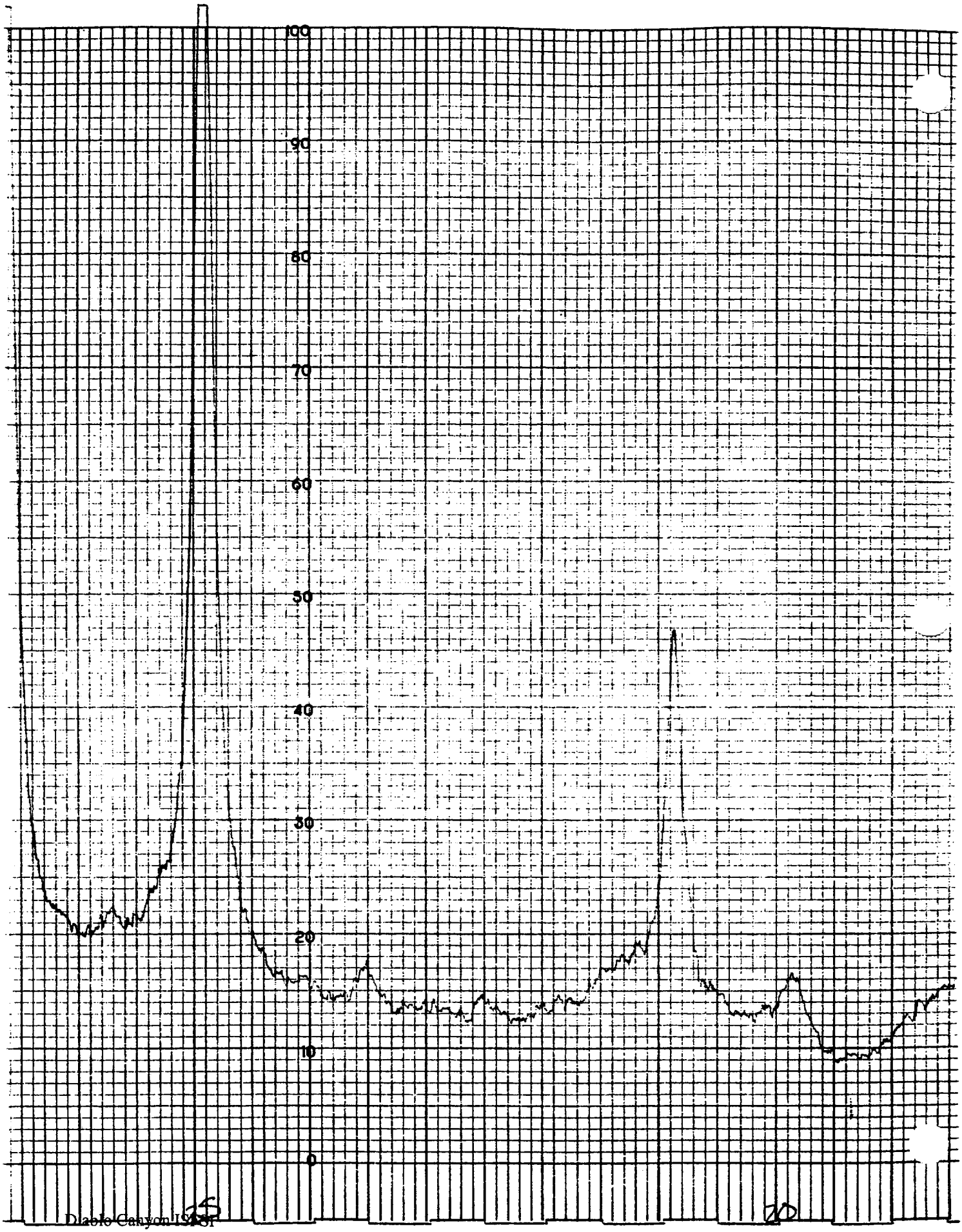

90
80
70
60
50
40
30
20
10
0
70
30
50
NO. BR R0790

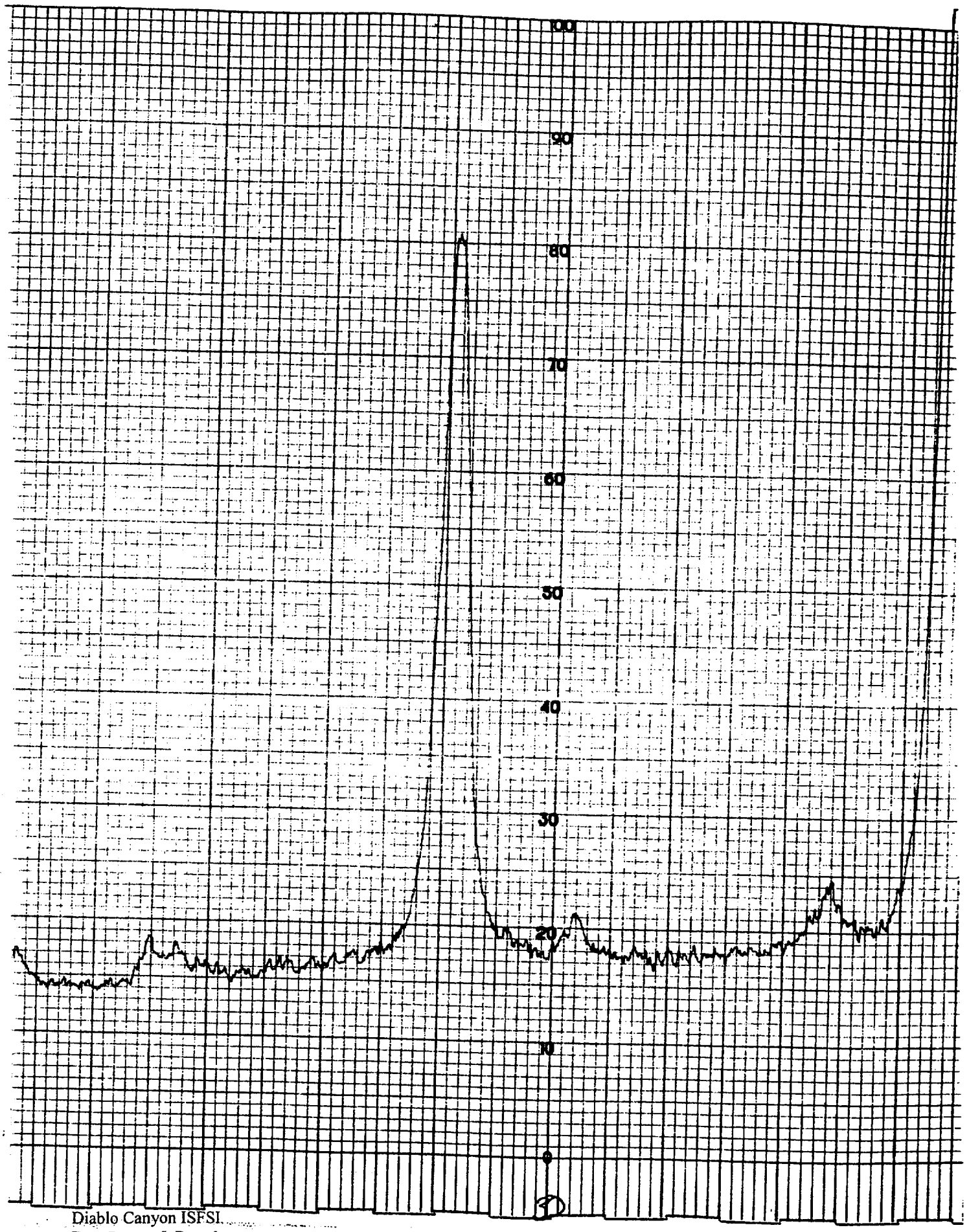

100
90
80
70
60
50
40
30
20
10
0
320

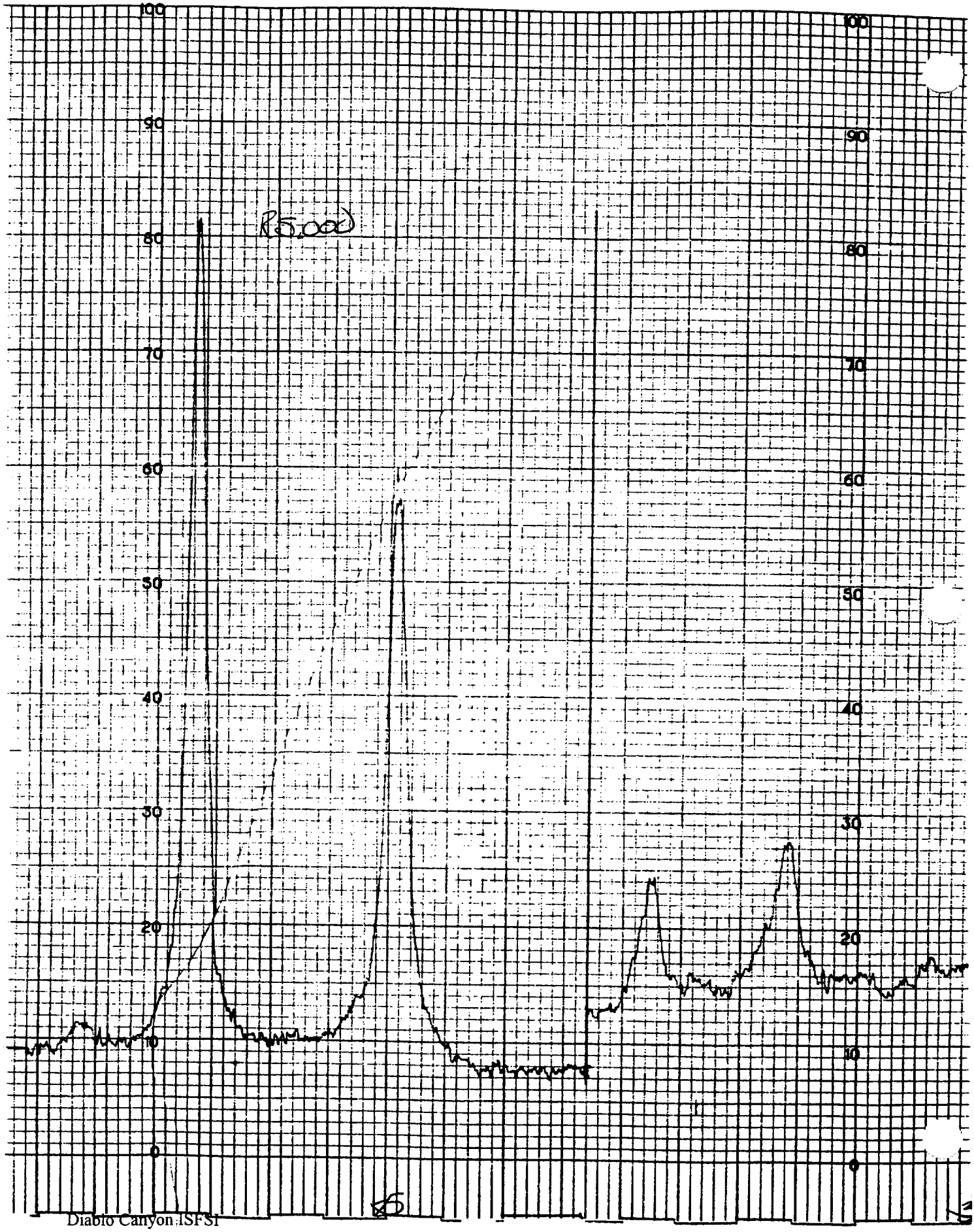

100
90
80
70
60
50
40
30
20
10
0
SPECTRUM PETROGRAPHICS
Bulk Glycol

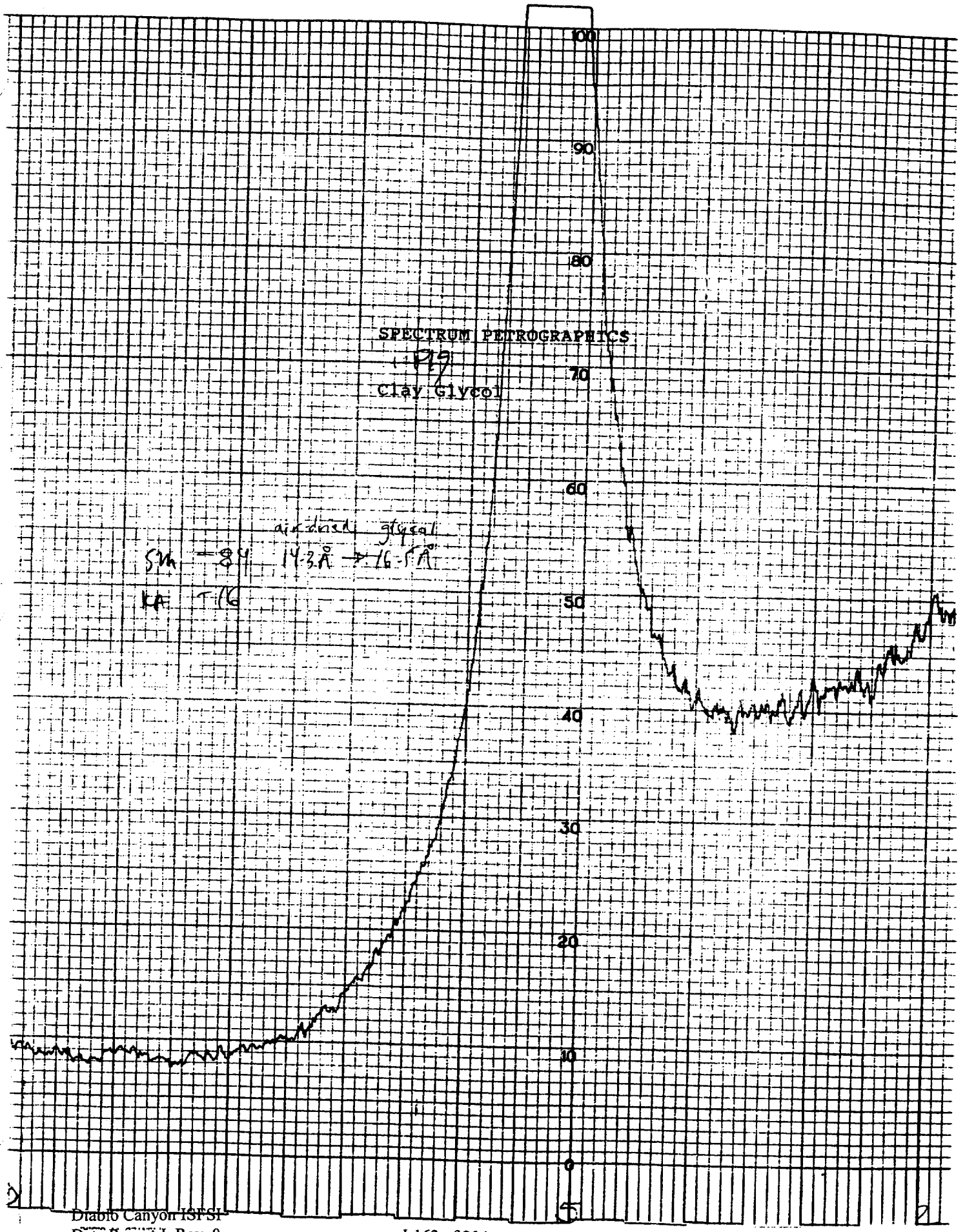

100
90
80
SPECTRUM PETROGRAPHICS
P-19
Clay
70
60
50
40
30
20
10
0

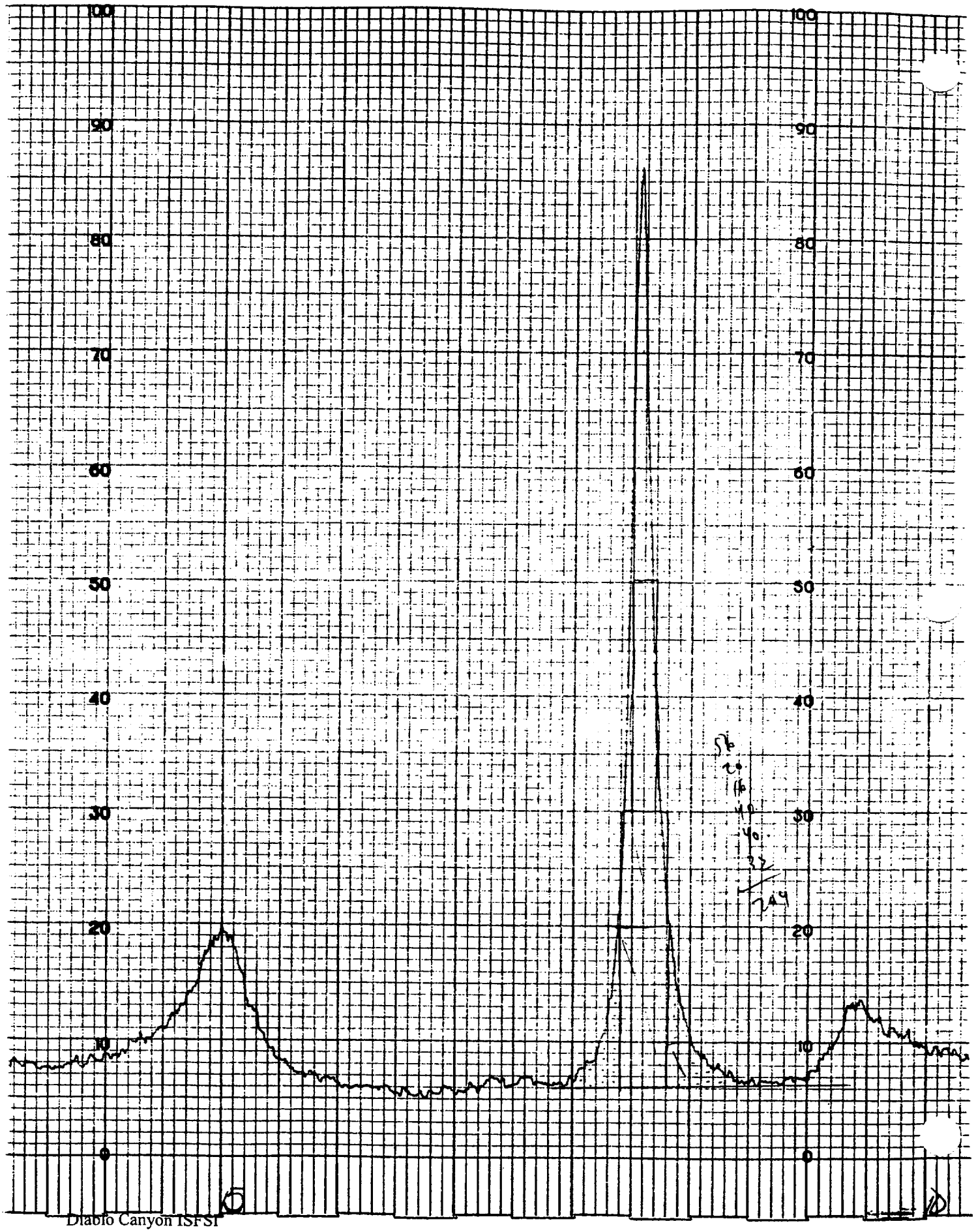

100
90
80
70
60
50
40
30
20
10
0
100
90
80
70
60
50
40
30
20
10
0

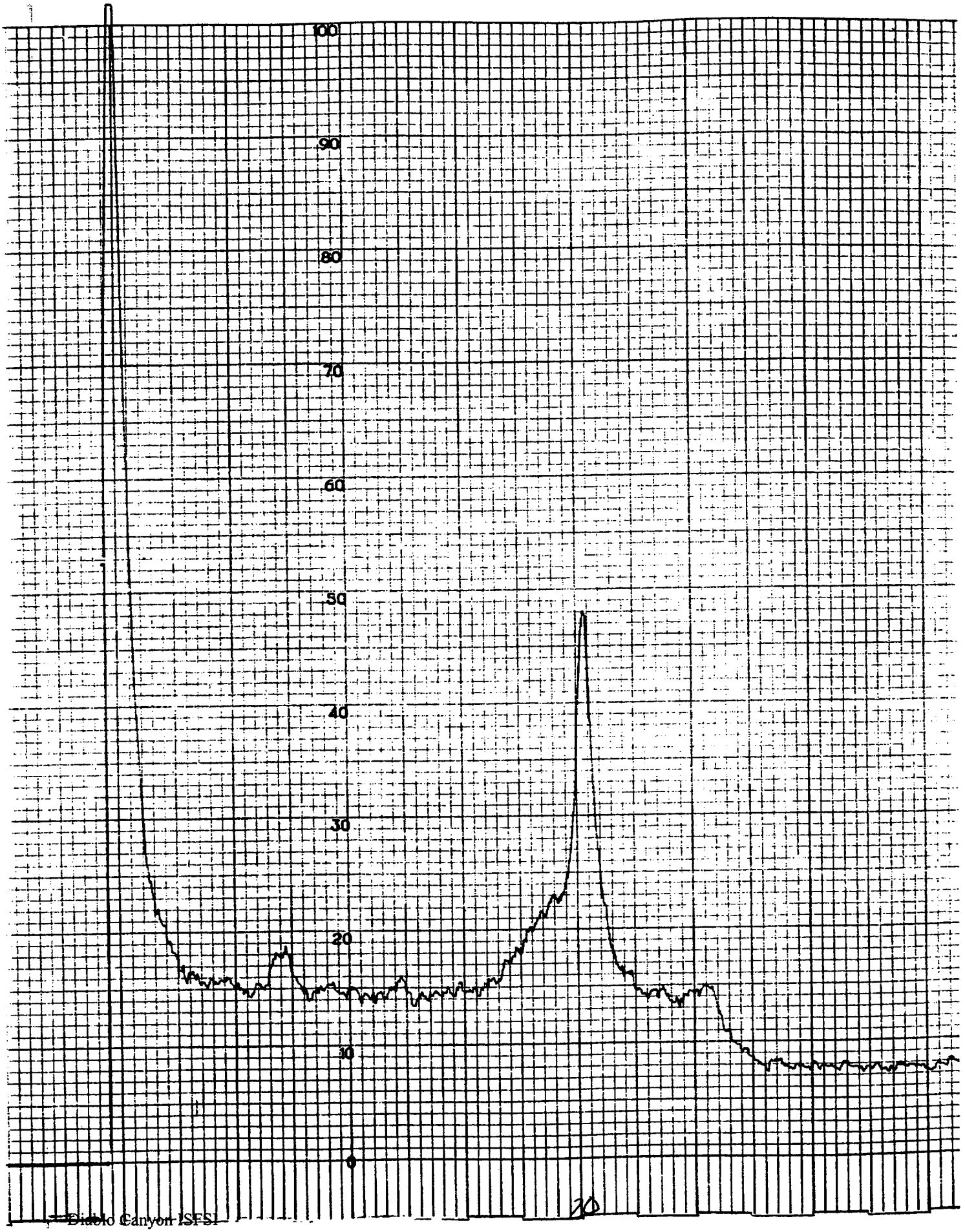

100
90
80
70
60
50
40
30
20
10
0
25
20

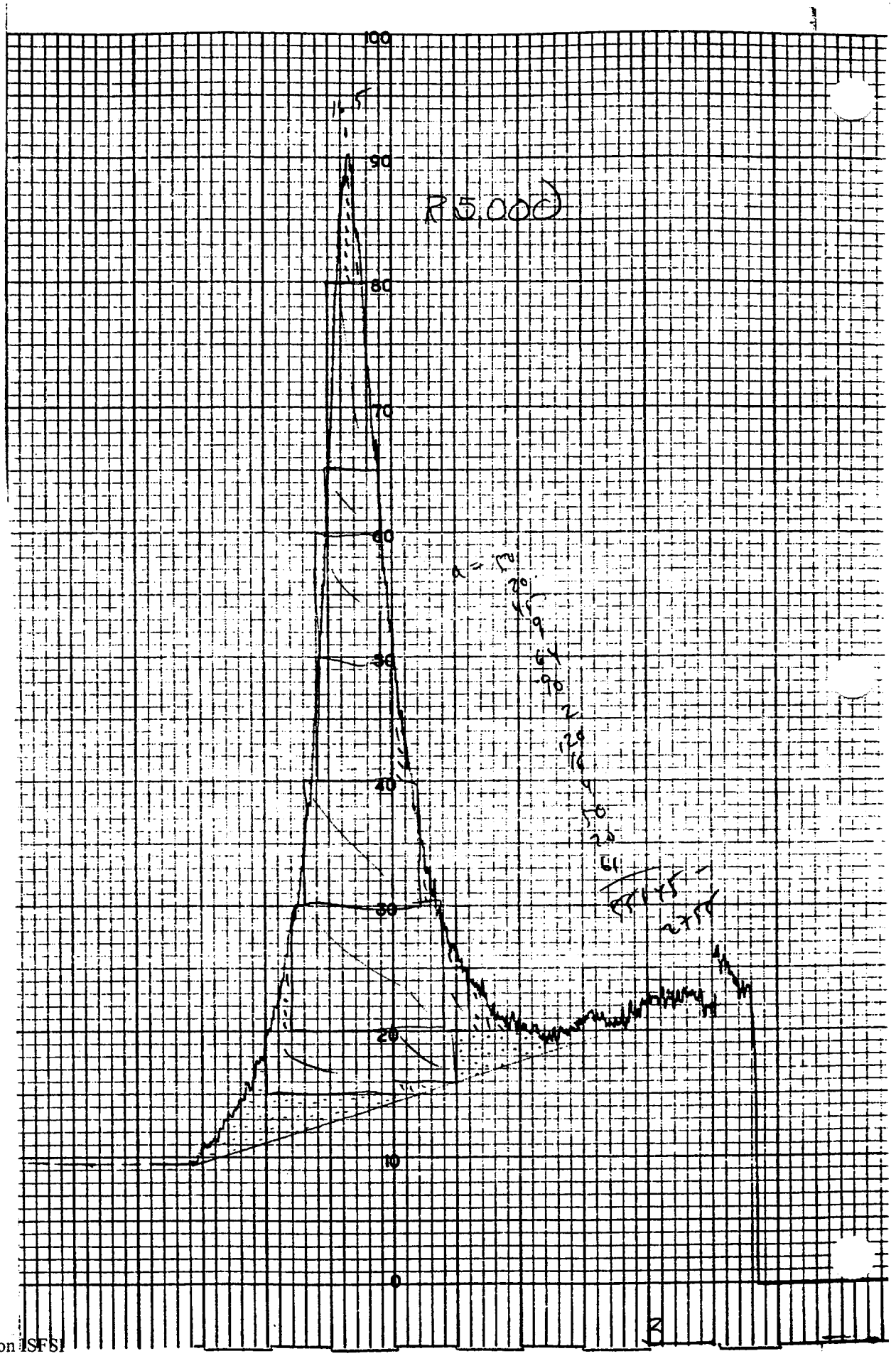

100
90
80
70
60
50
40
30
20
10
0

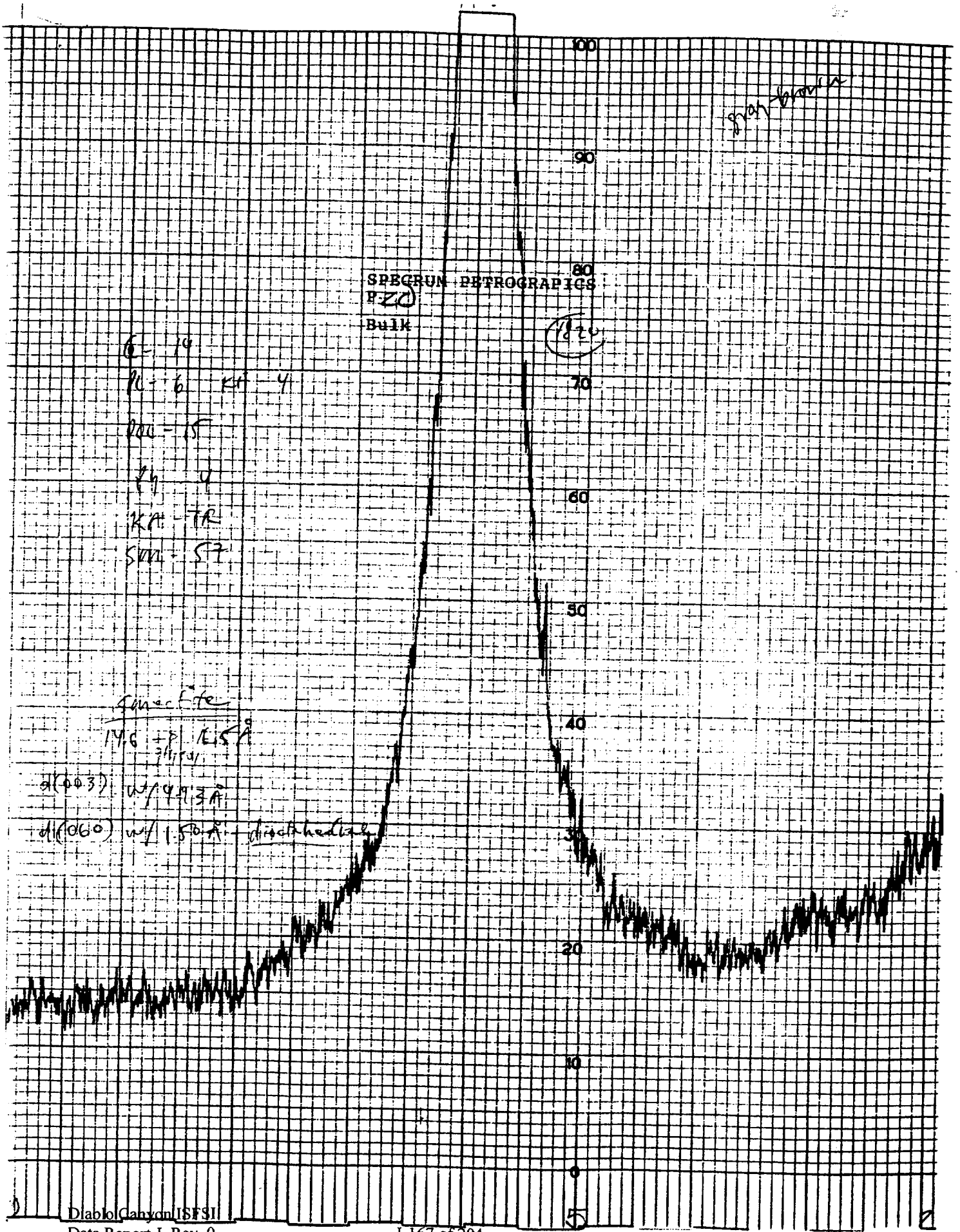

100
90
80
70
60
50
40
30
20
10
0
(5,000)

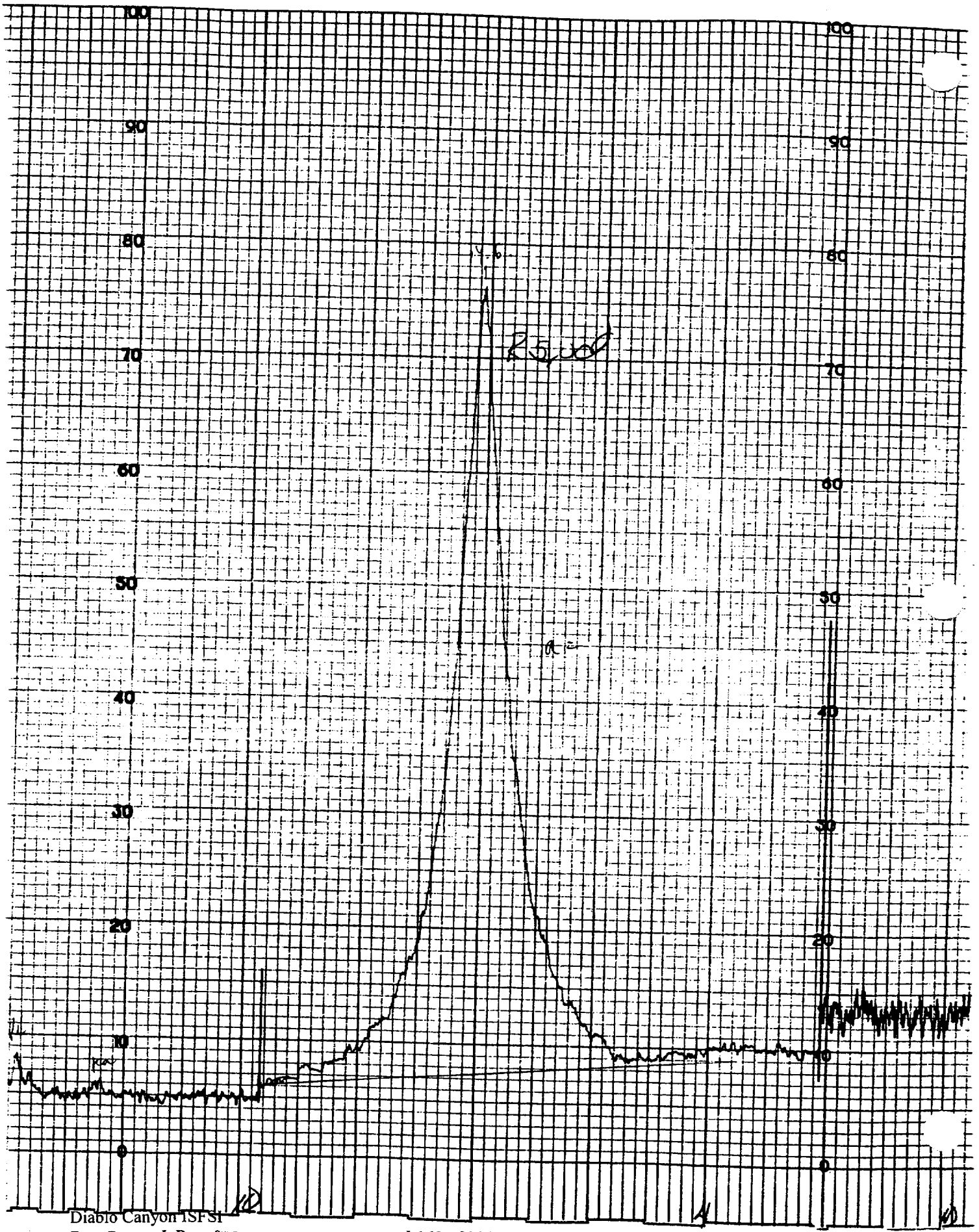

SPECTRUM PETROGRAPHICS
Clay Glycol
100
90
80
70
60
50
40
30
20
10
0
air dried glycol
SM -84 14.3Å → 16.5Å
KA 7.16

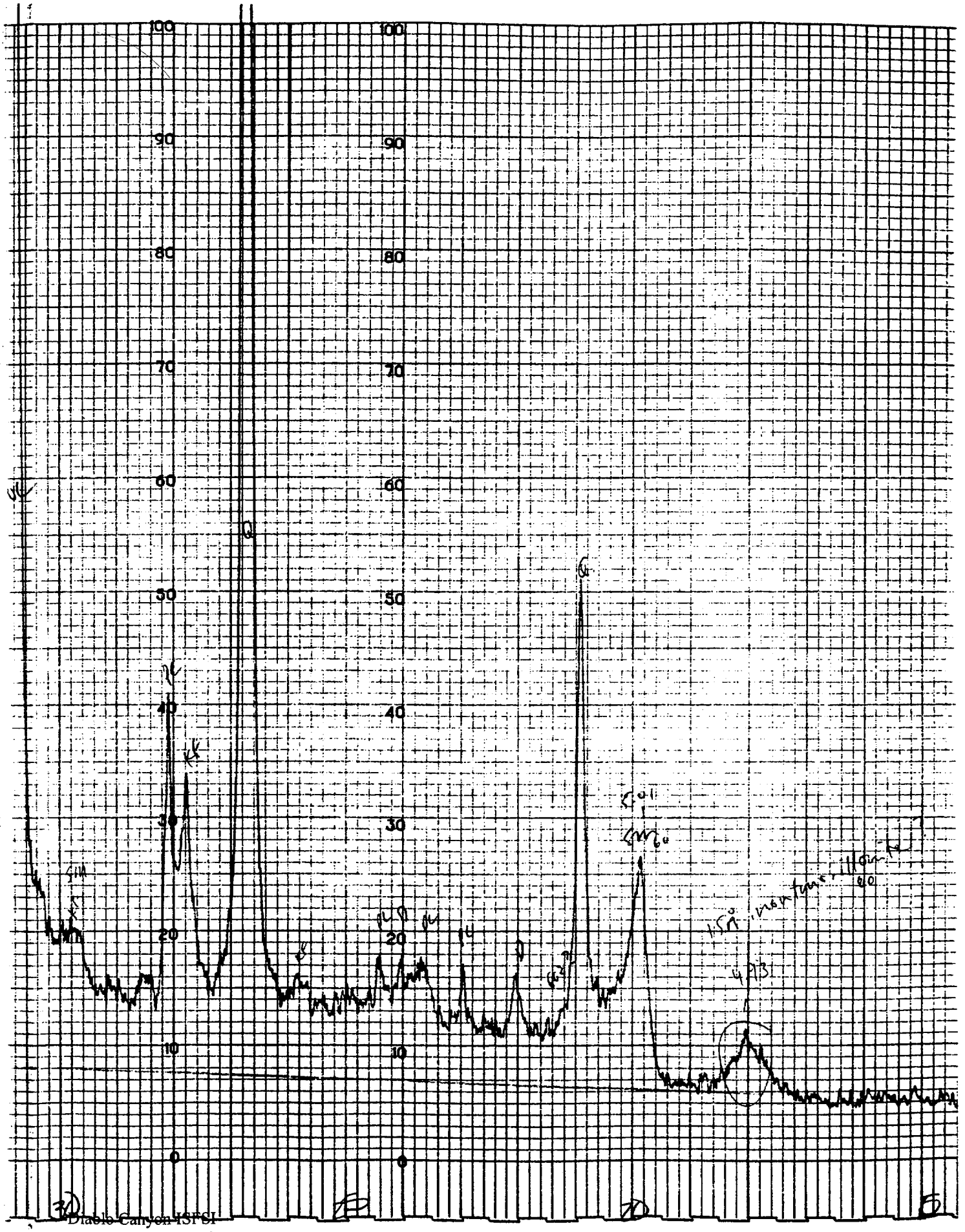

100
90
80
70
60
50
40
30
20
10
0

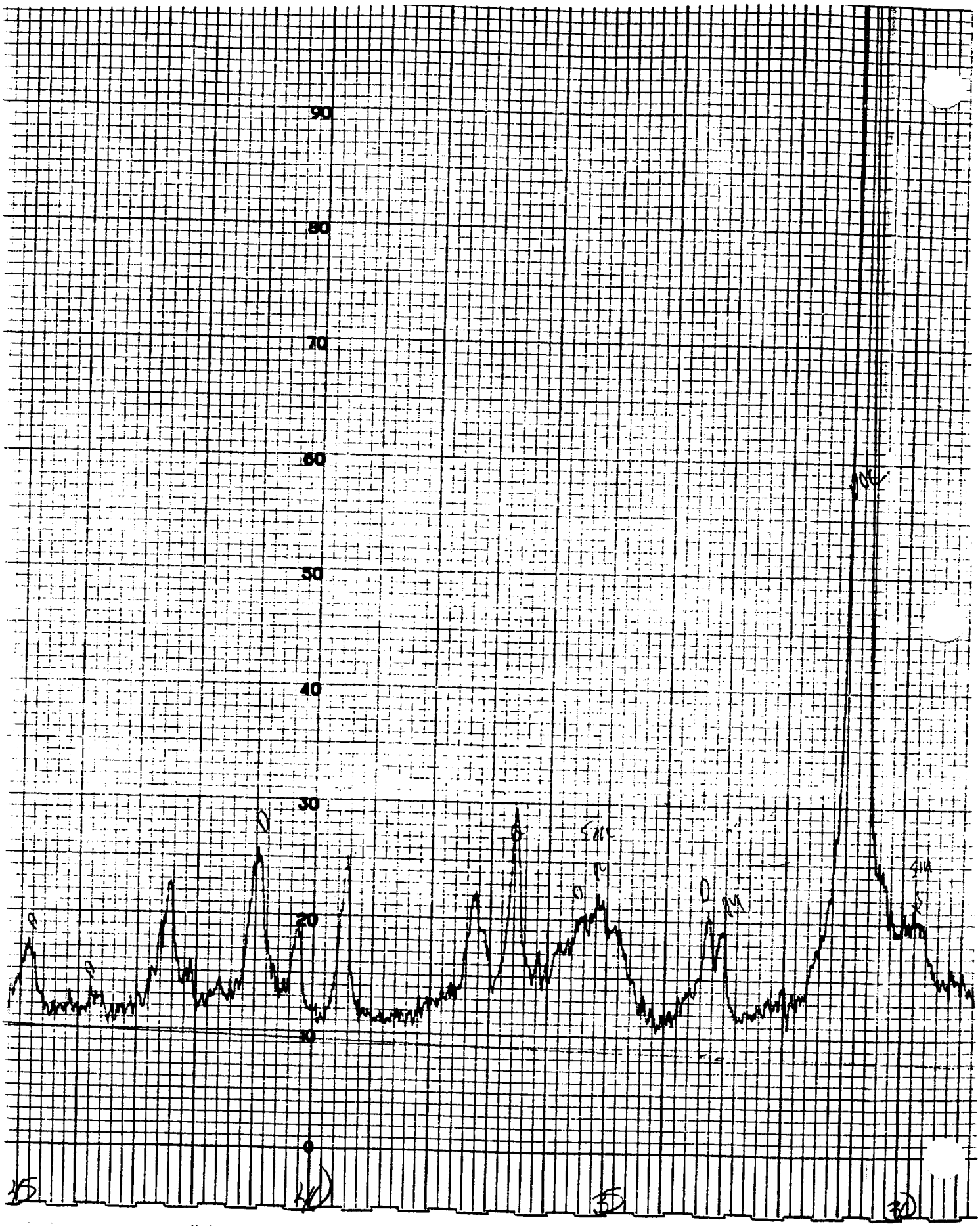

100
90
80
70
60
50
40
30
20
10
0
70

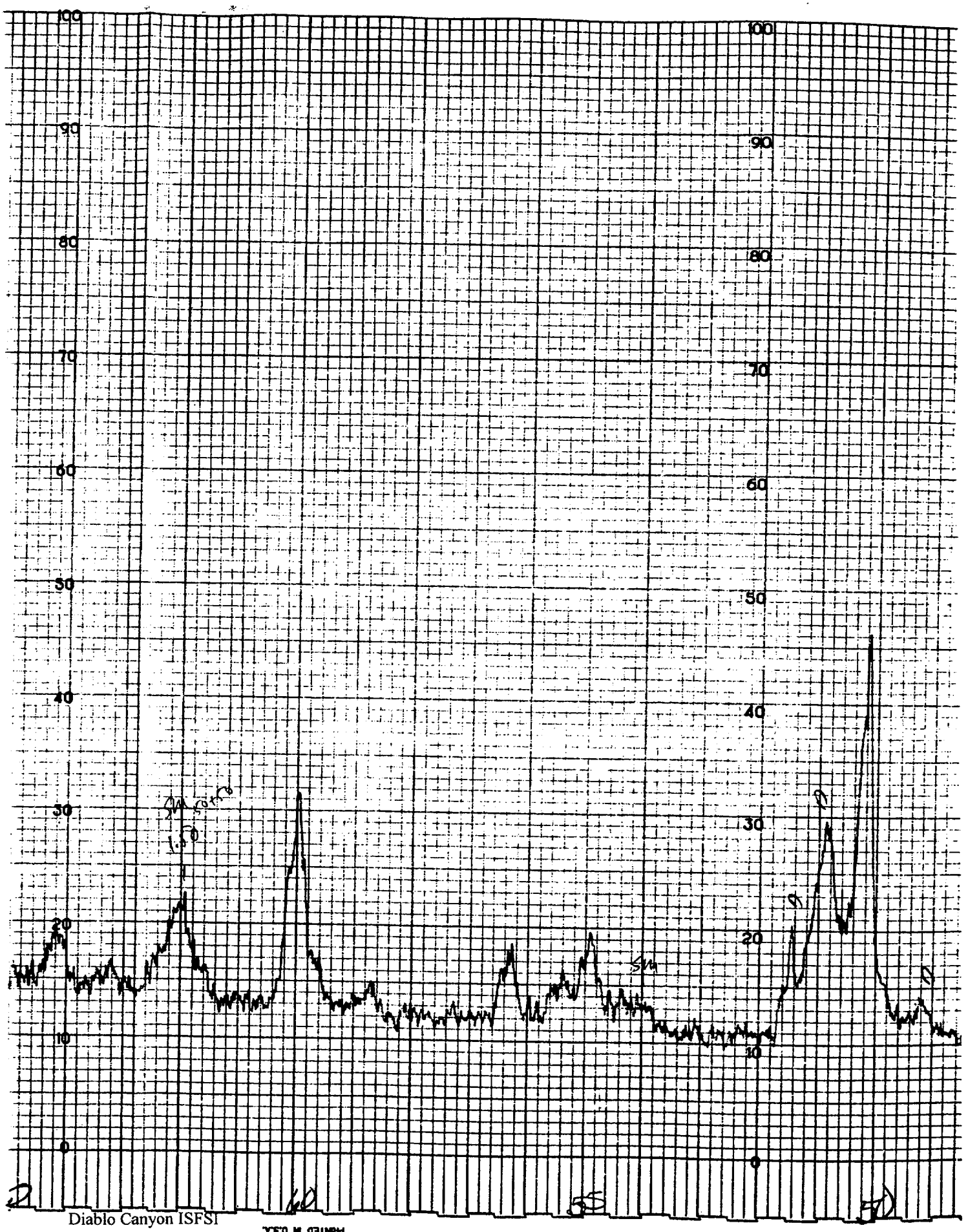

100
90
80
70
60
50
40
30
20
10
0
R5000

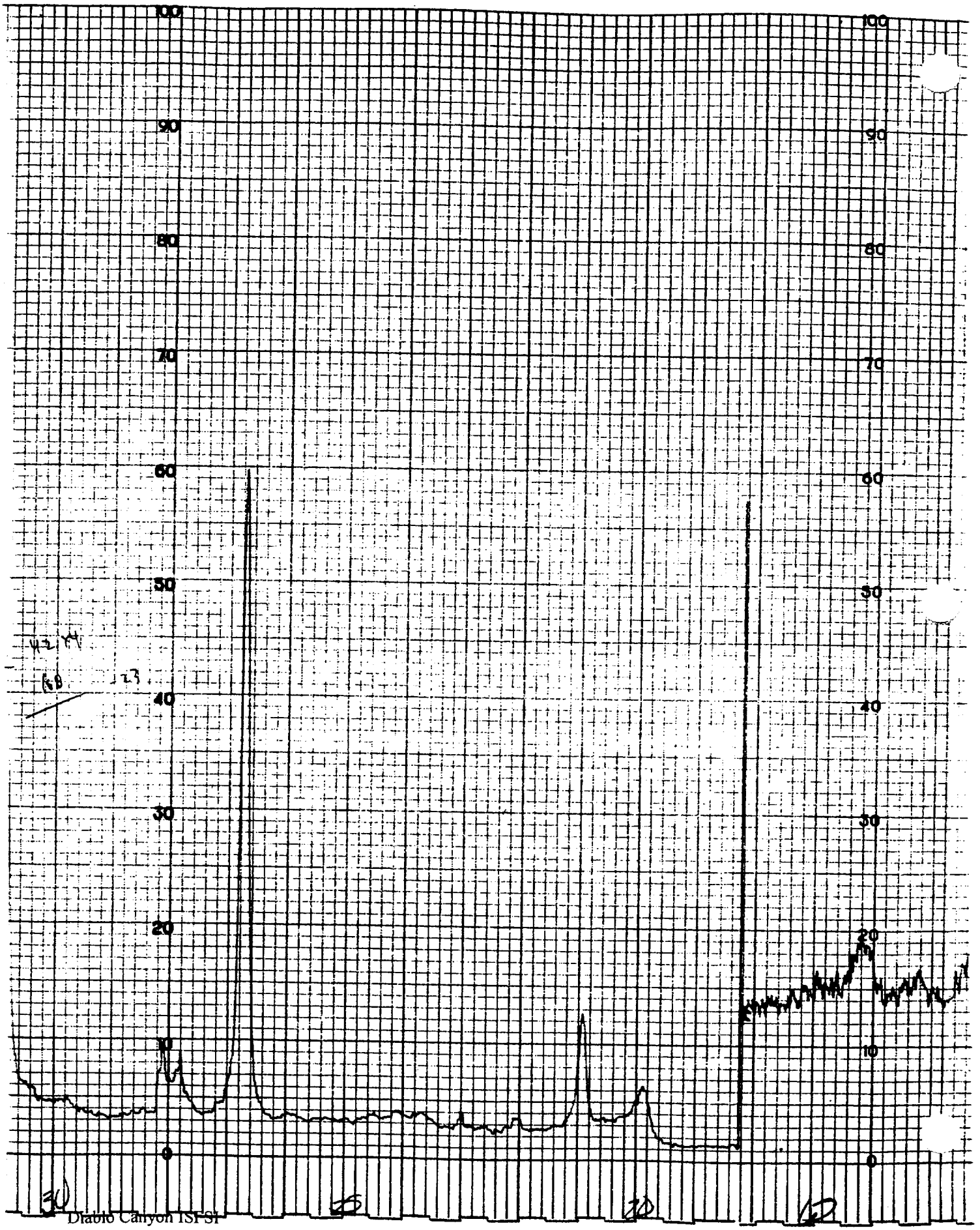

SPECRUN PETROGRAPHICS
P-20
Bulk
100
90
80
70
60
50
40
30
20
10
0
5
Ca - 14
Fe - 6 KA - 4
Na - 15
Th - 4
KA - 78
SM - 57
Gonnectite
14.6 + 8 1.15Å
d(003) w/ 4.93Å
d(060) w/ 1.50Å - dioctahedral

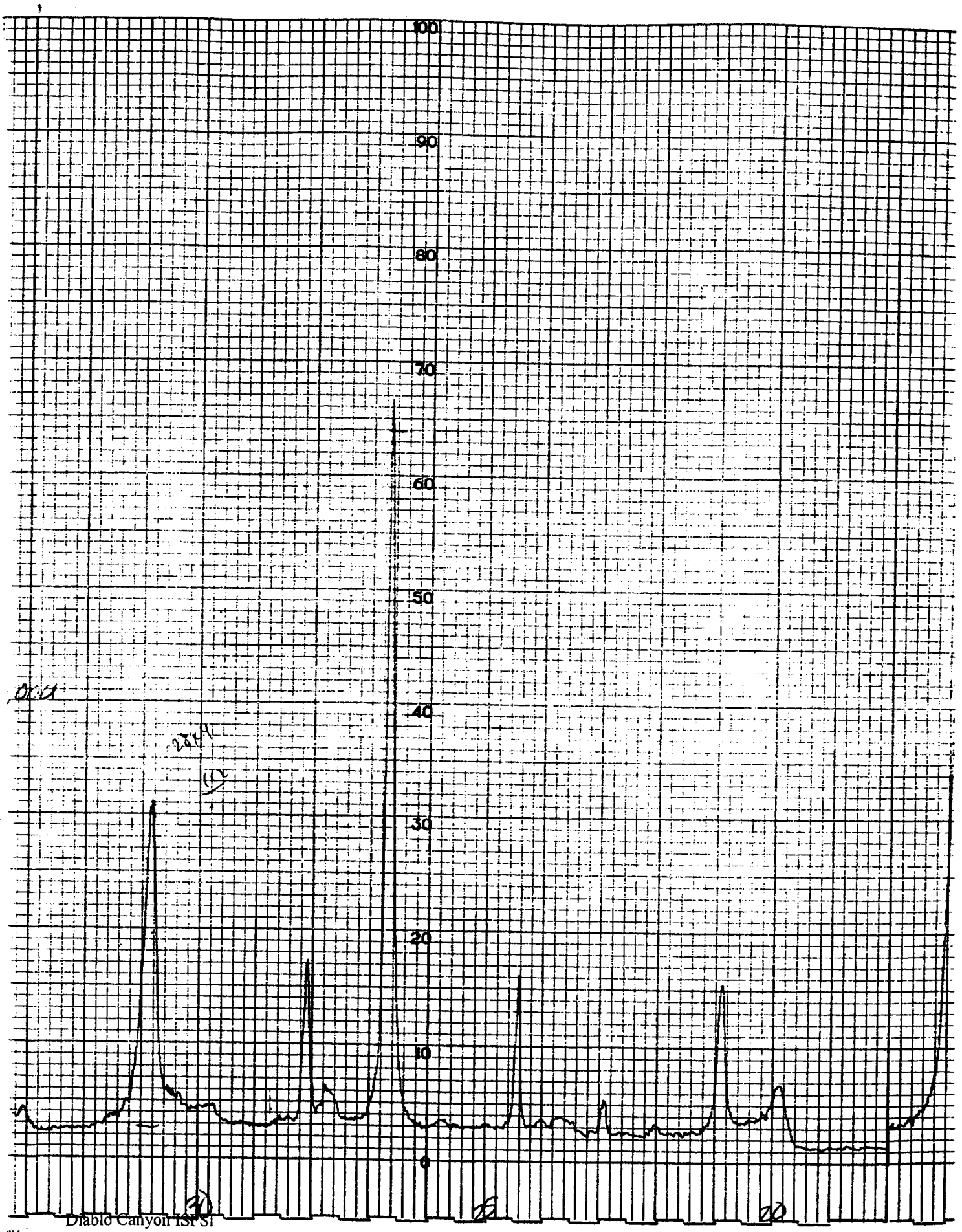

100
90
80
70
60
50
40
30
20
10
0
R5,00

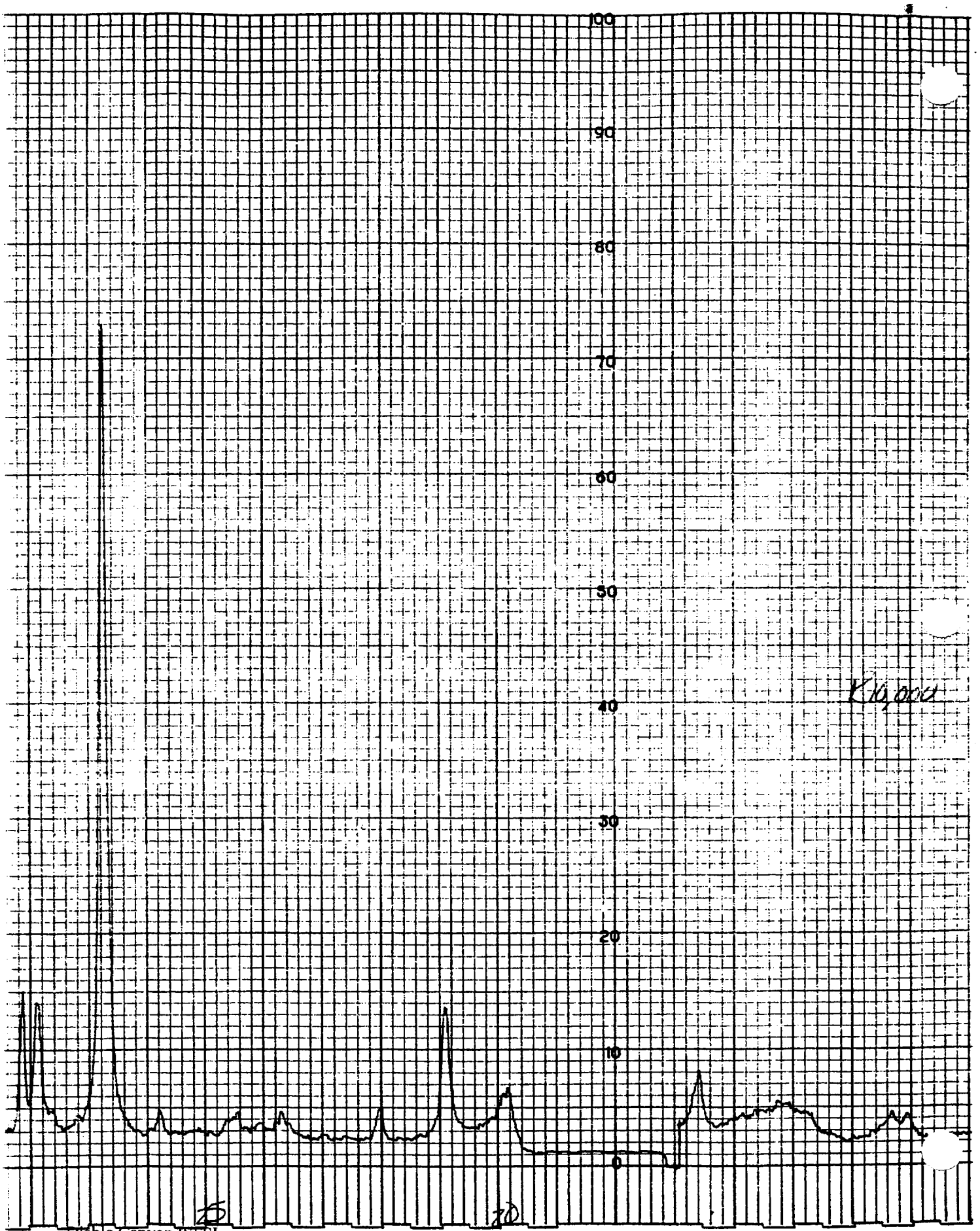

100
90
80
70
60
50
40
30
20
10
0

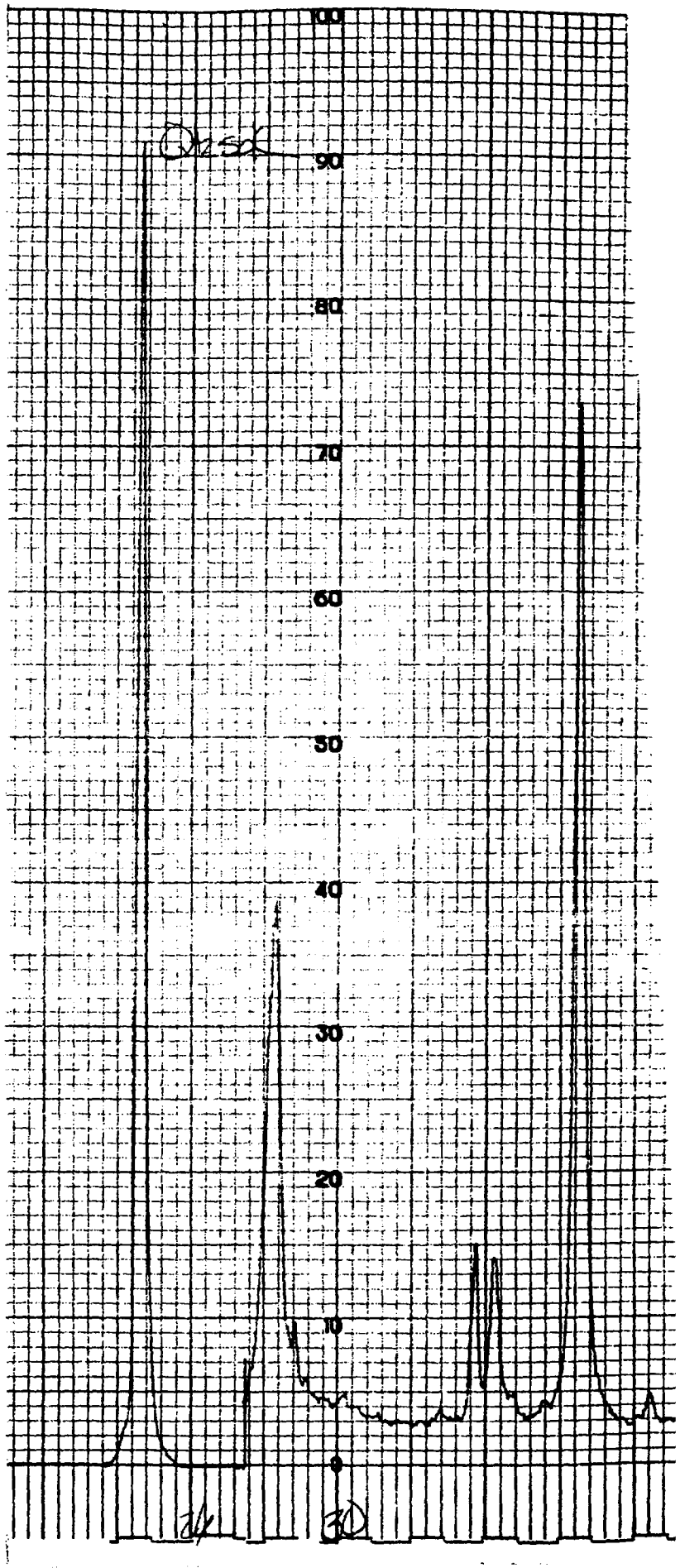

90
80
70
60
50
40
30
20
10
0

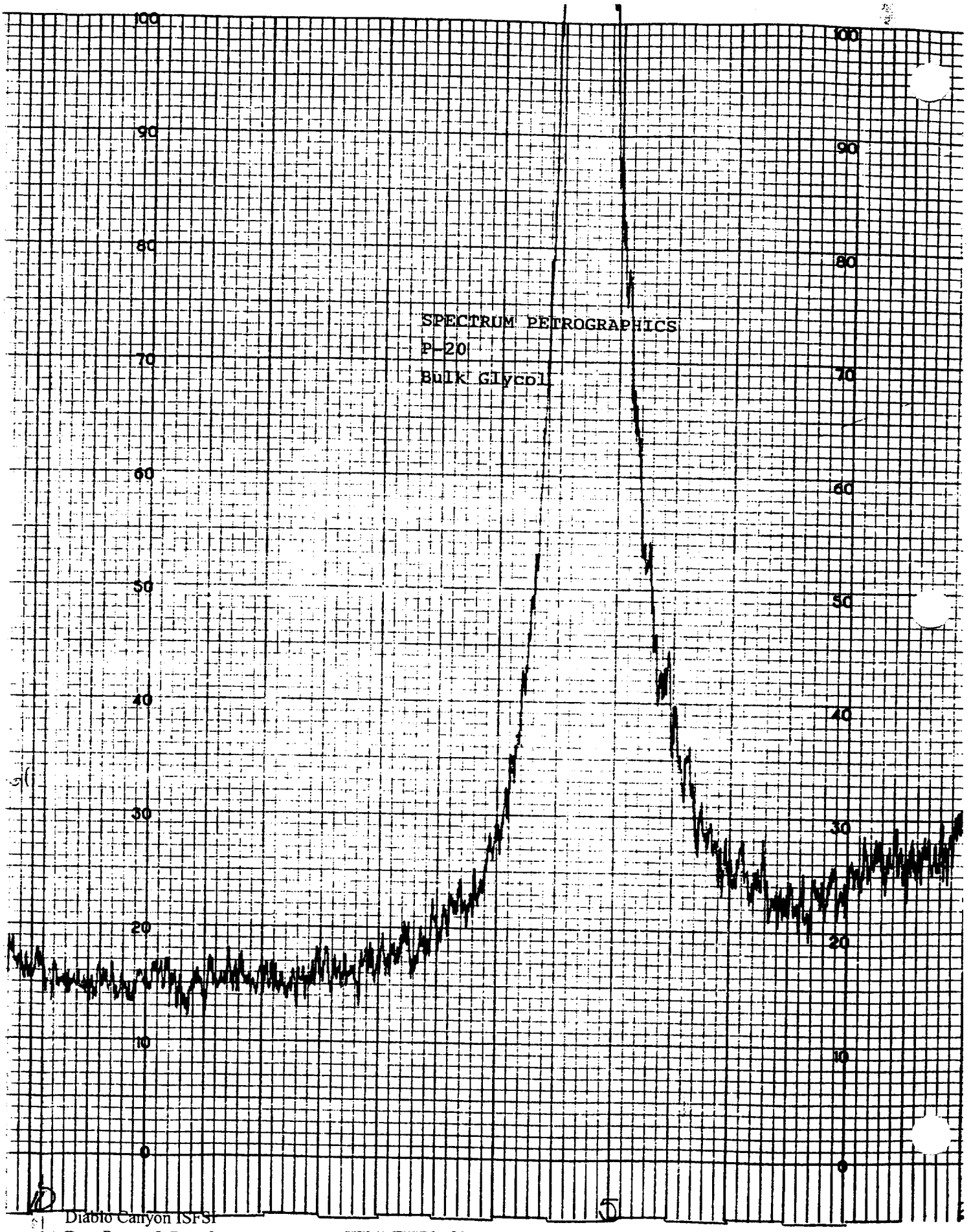

100
90
80
70
60
50
40
30
20
10
0
100
90
80
70
60
50
40
30
20
10
0

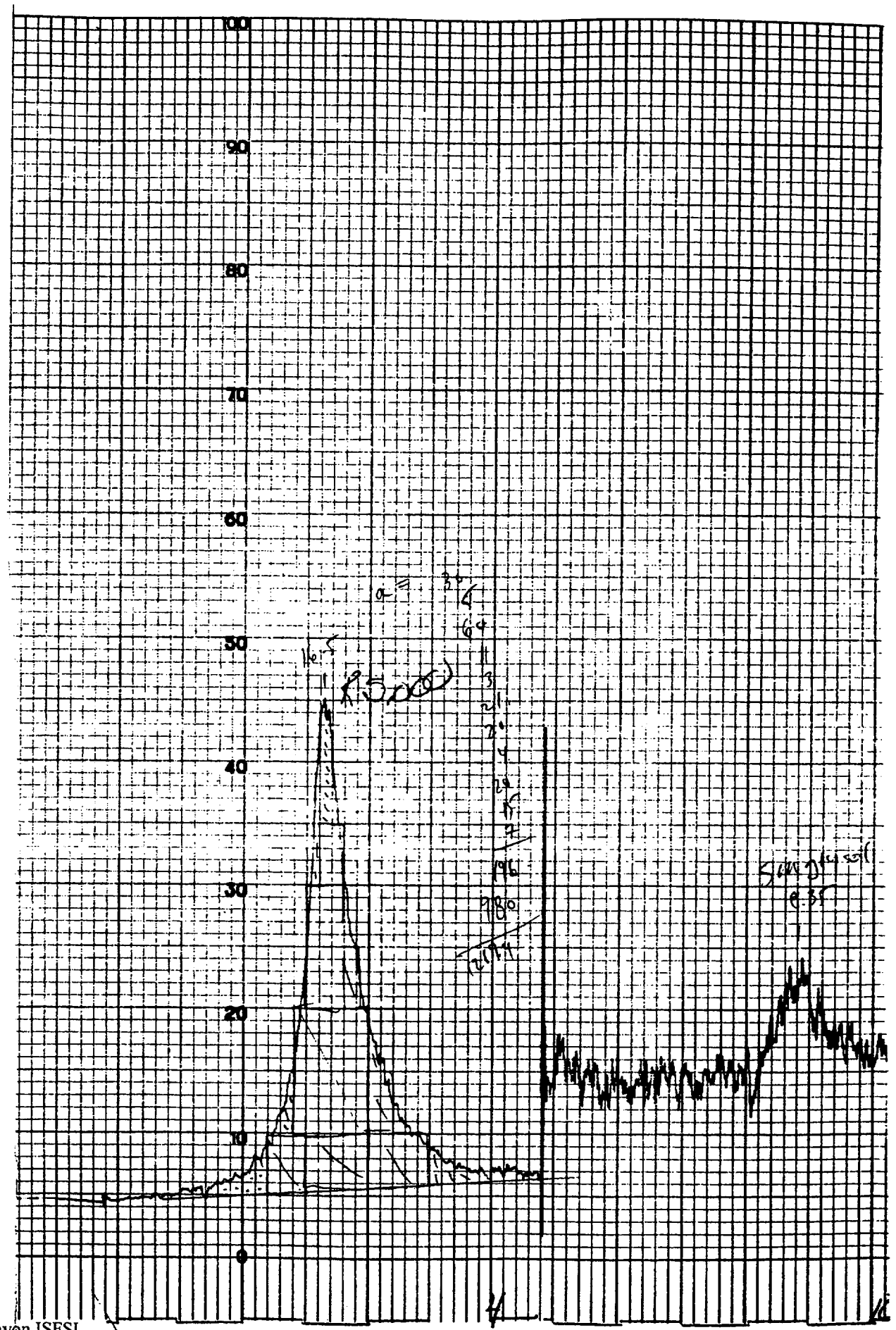

100
90
80
70
60
50
40
30
20
10
0
100
90
80
70
60
50
40
30
20
10
0


100
90
80
70
60
50
40
30
20
10
0

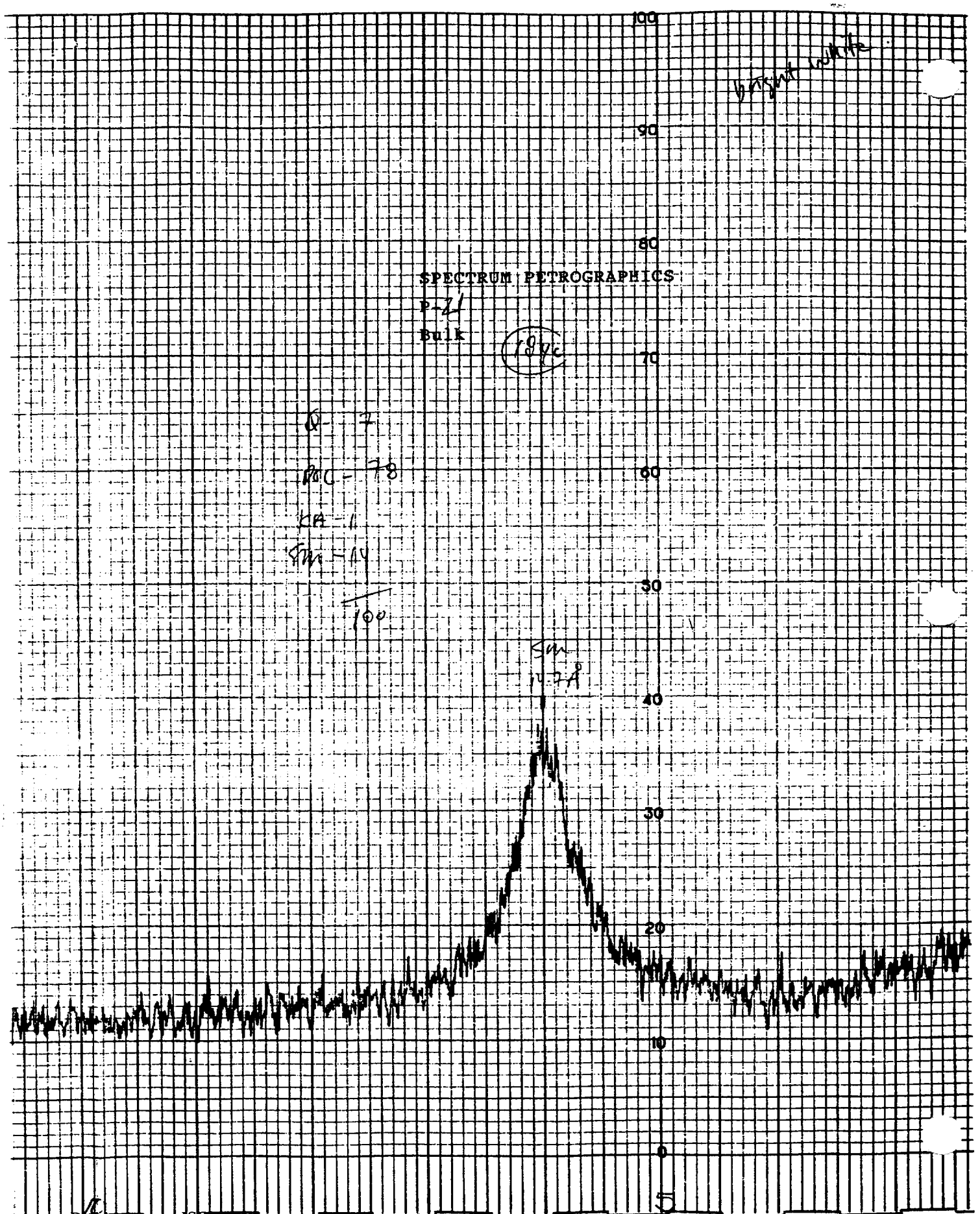

100
90
80
70
60
50
40
30
20
10
0
K10,000
5
10


100
90
80
70
60
50
40
30
20
10
0

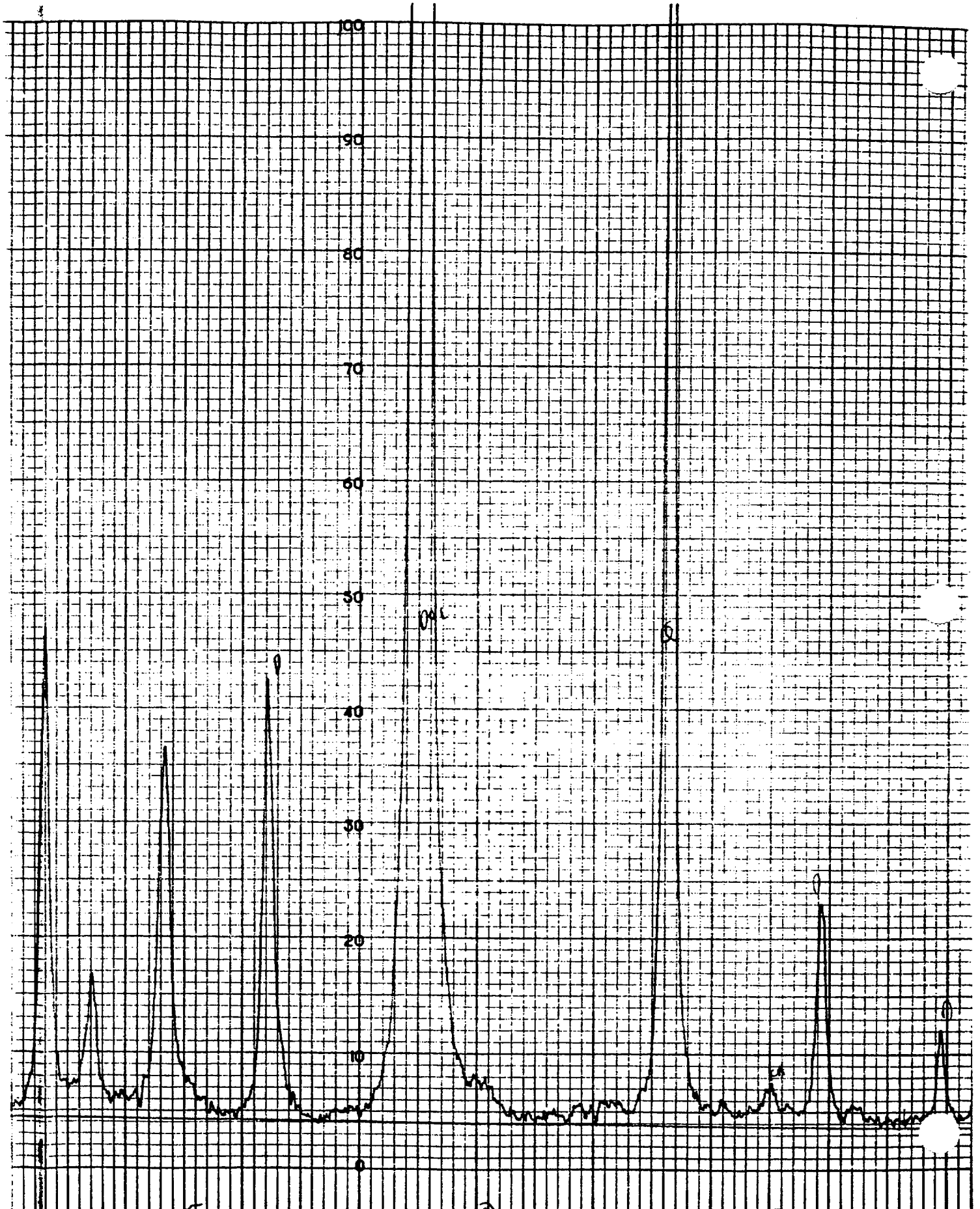

SPECTRUM PETROGRAPHICS
P-20
Bulk Glycol
100
90
80
70
60
50
40
30
20
10
0

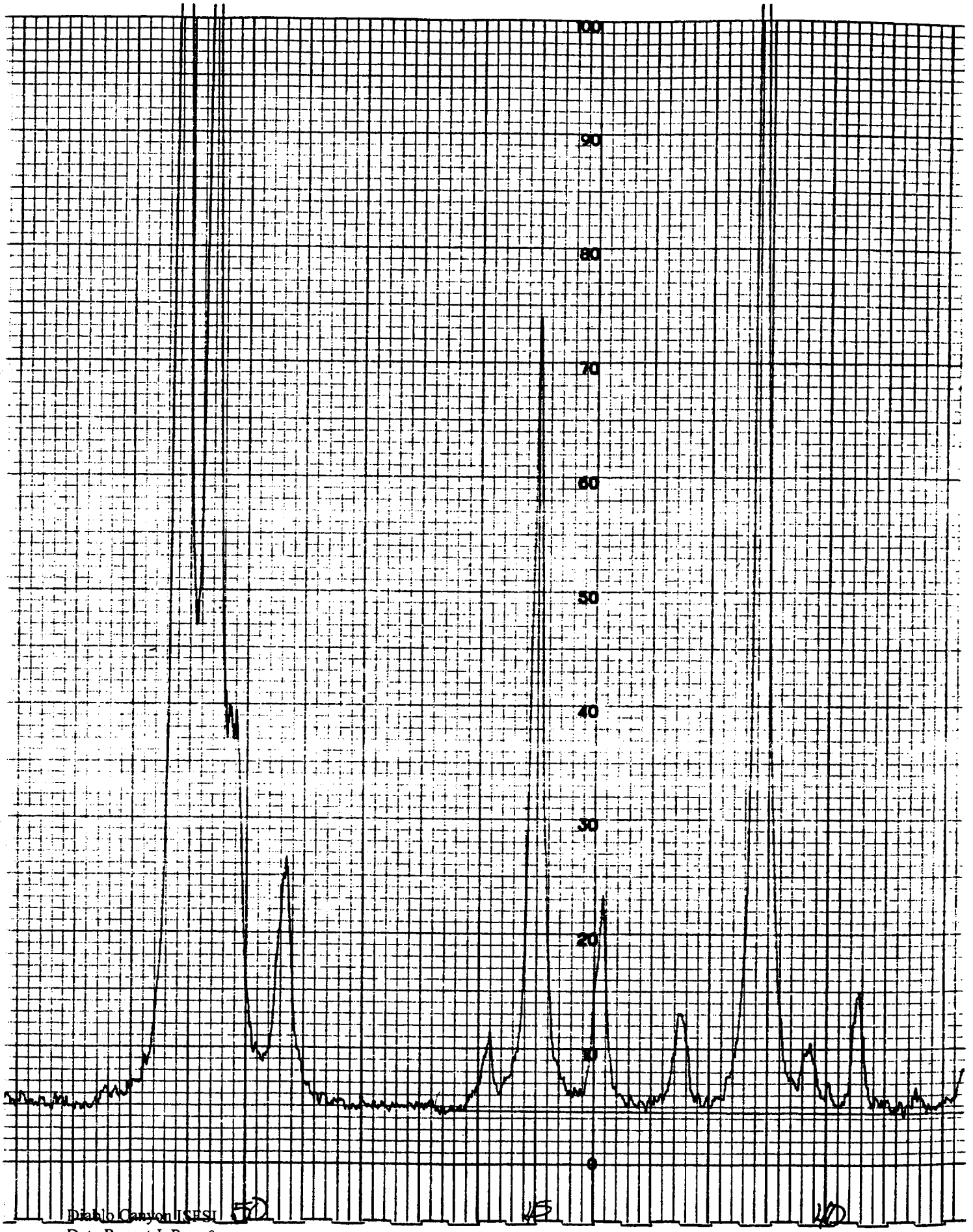


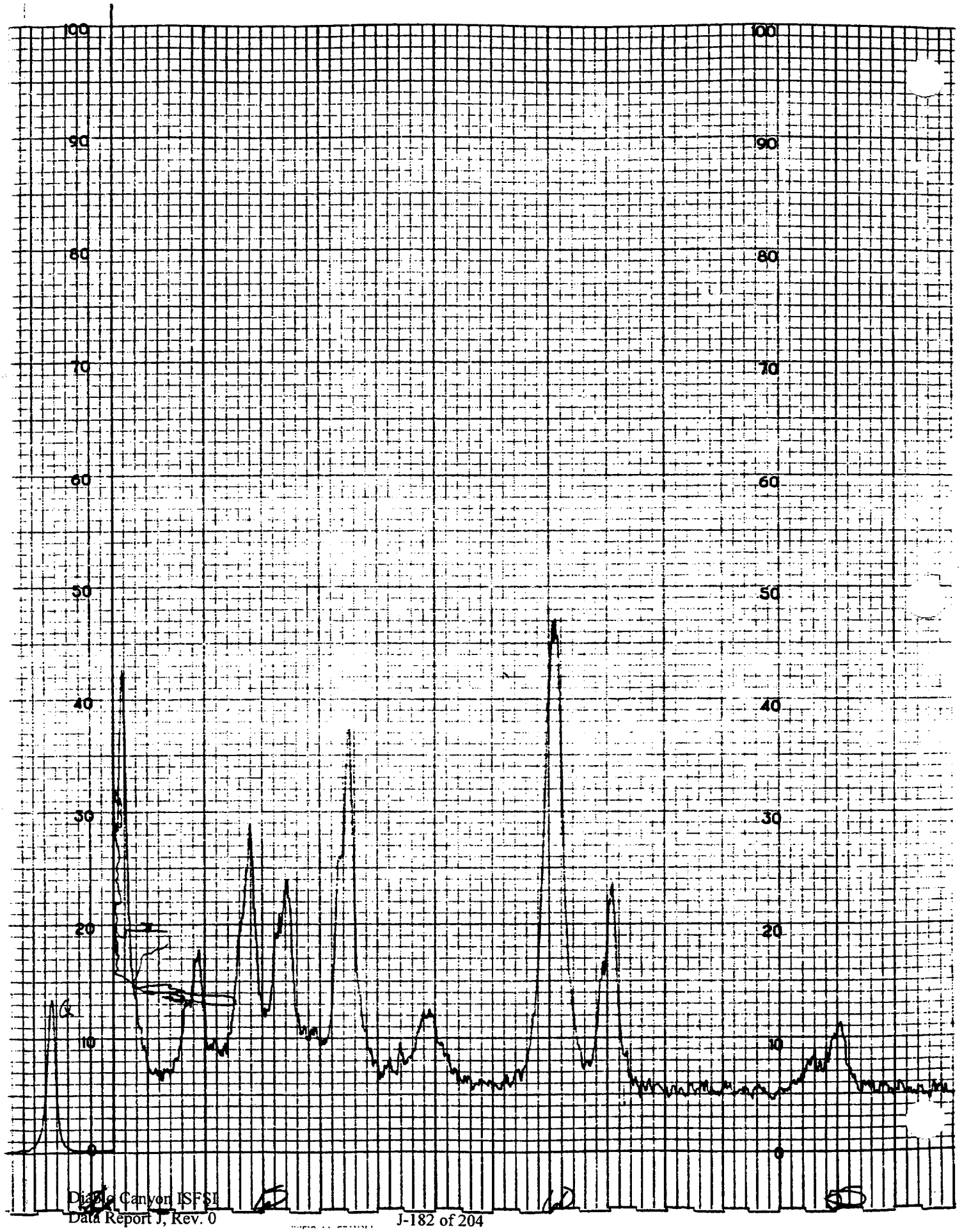
GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK

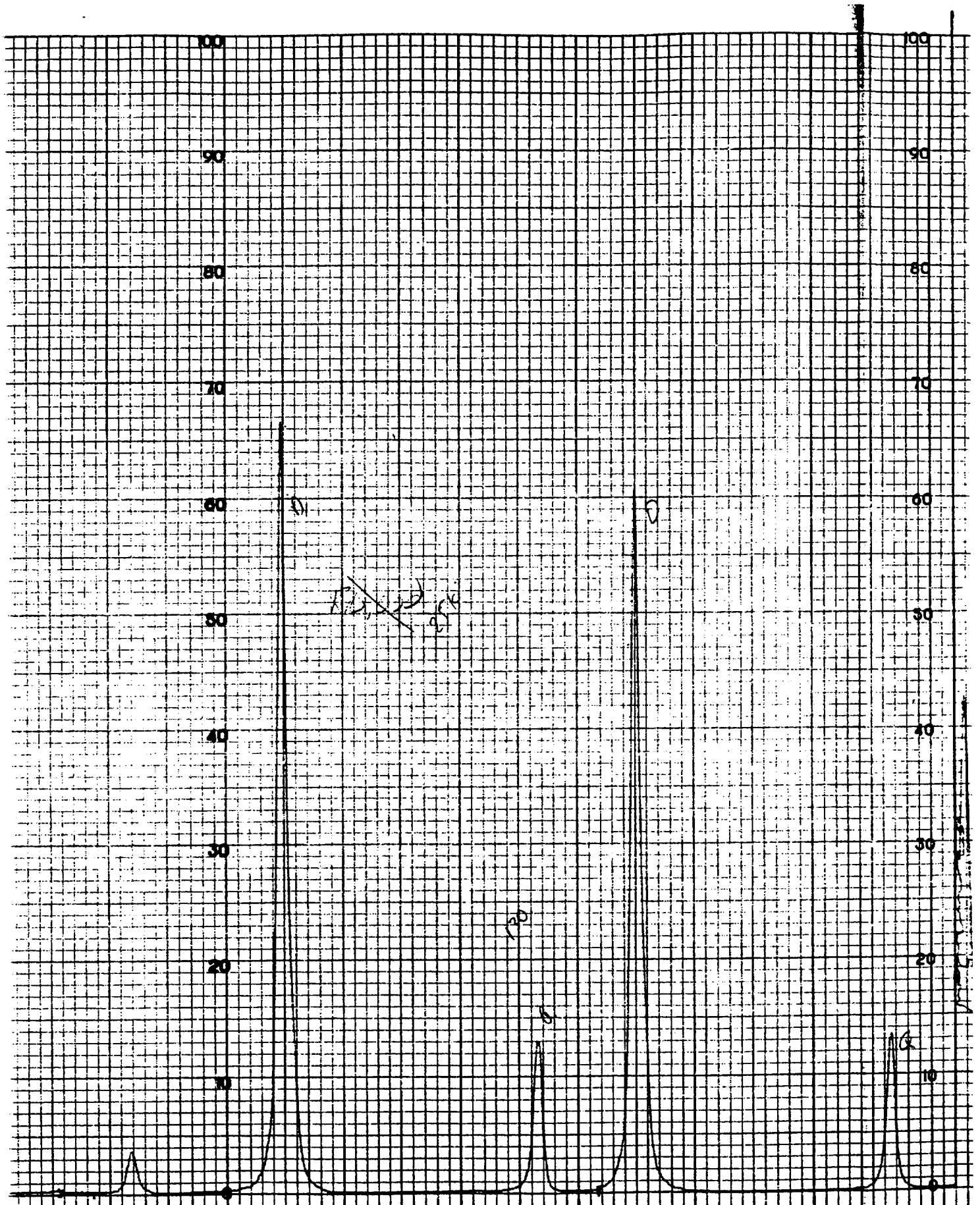

100
90
80
70
60
50
40
30
20
10
0
bright white
SPECTRUM PETROGRAPHICS
P-21
Bulk
18%
Q- 7
PLC- 78
KA-1
Sm-14
100
Sm
12.7A

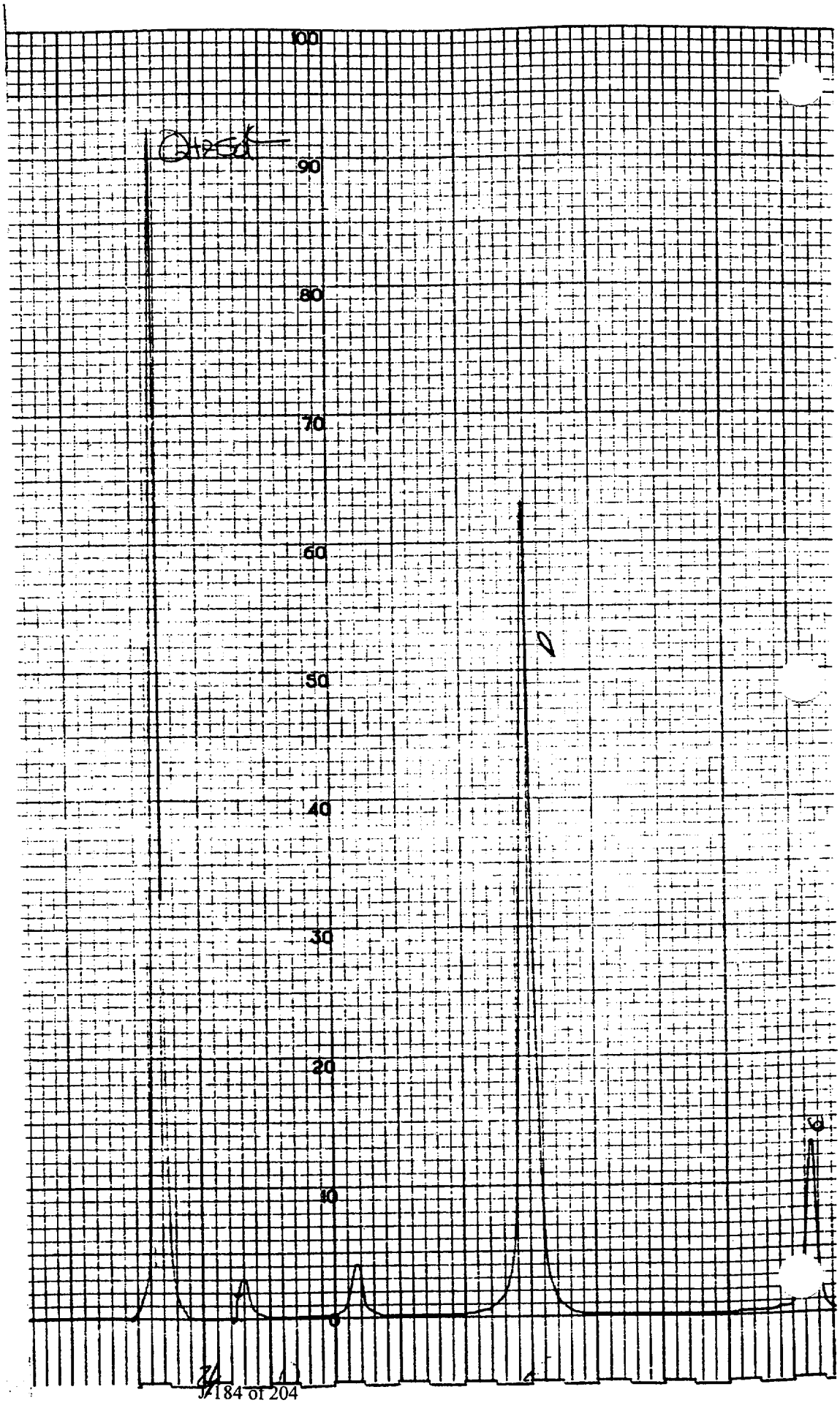
100
90
80
70
60
50
40
30
20
10
0
Q
S
R
A
55
60

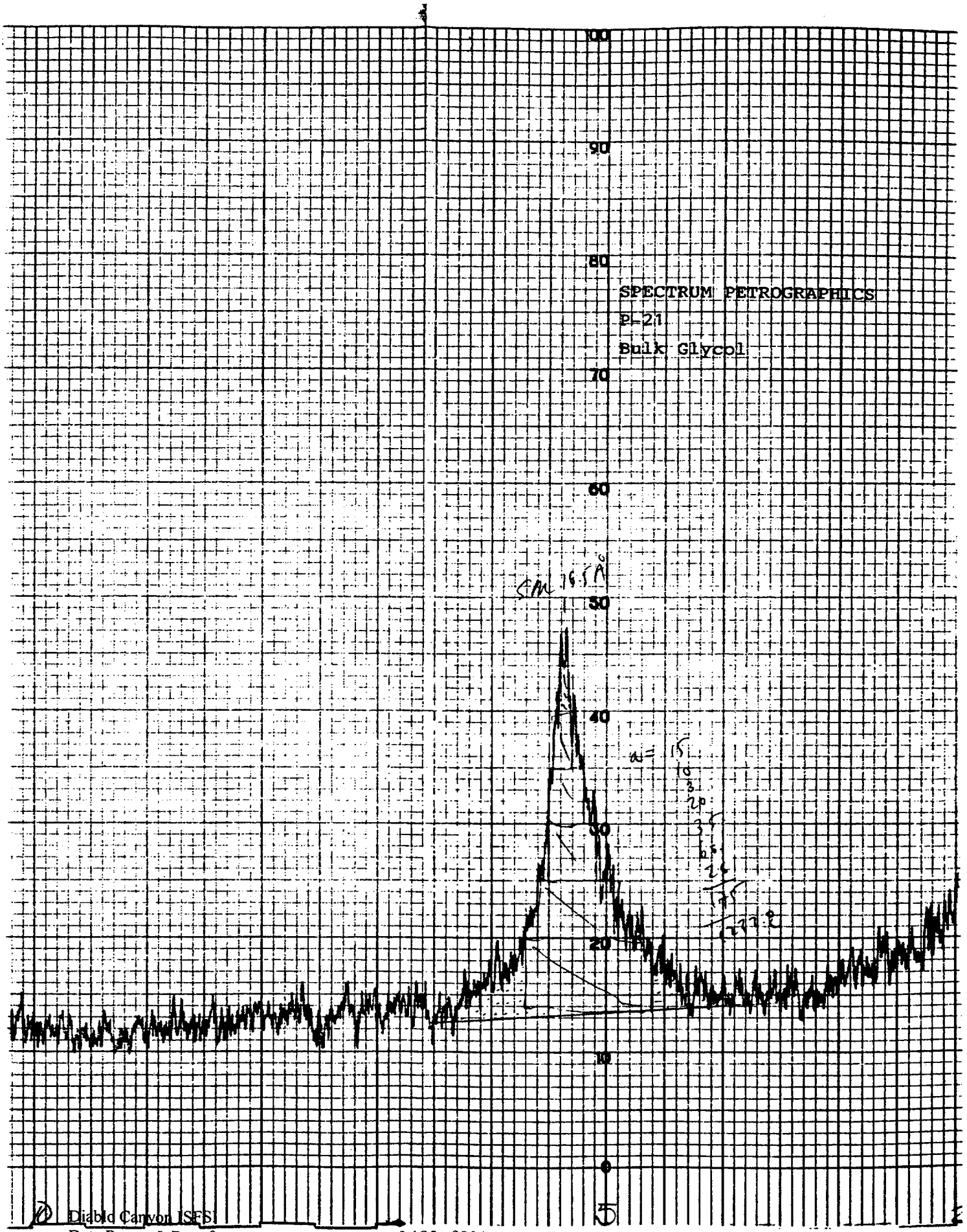

100
90
80
70
60
50
40
30
20
10
0

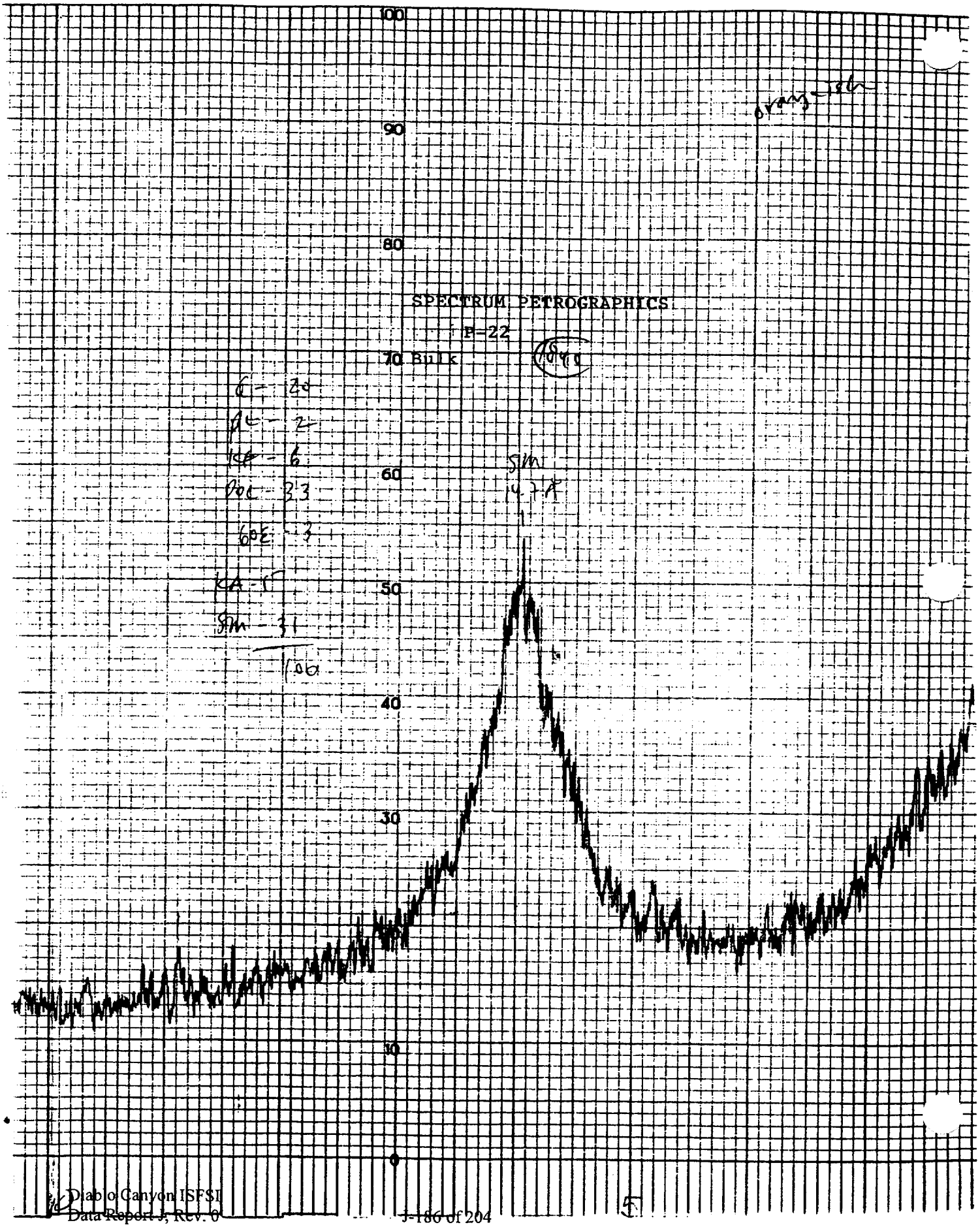

100
90
80
70
60
50
40
30
20
10
0

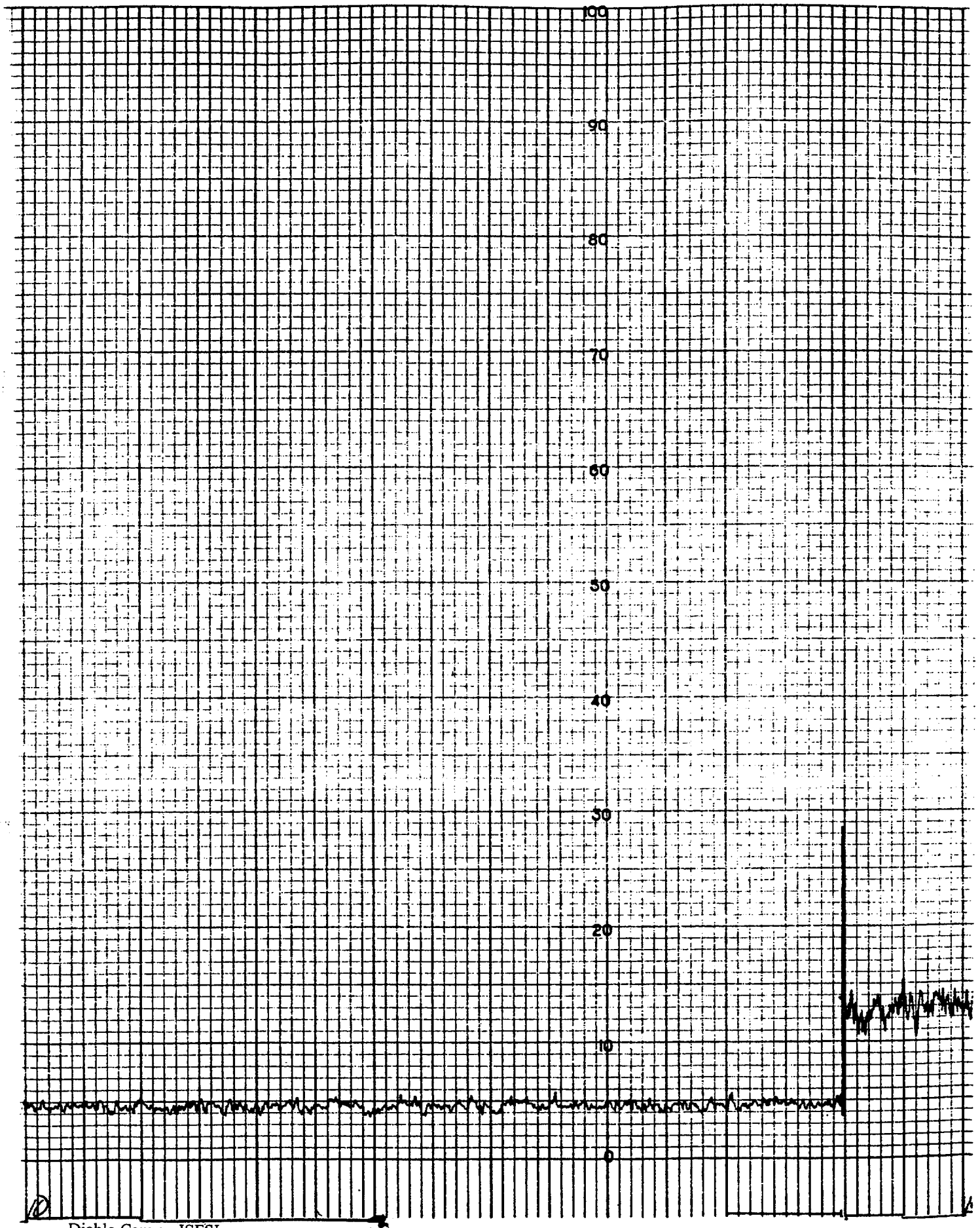

100
90
80
70
60
50
40
30
20
10
0

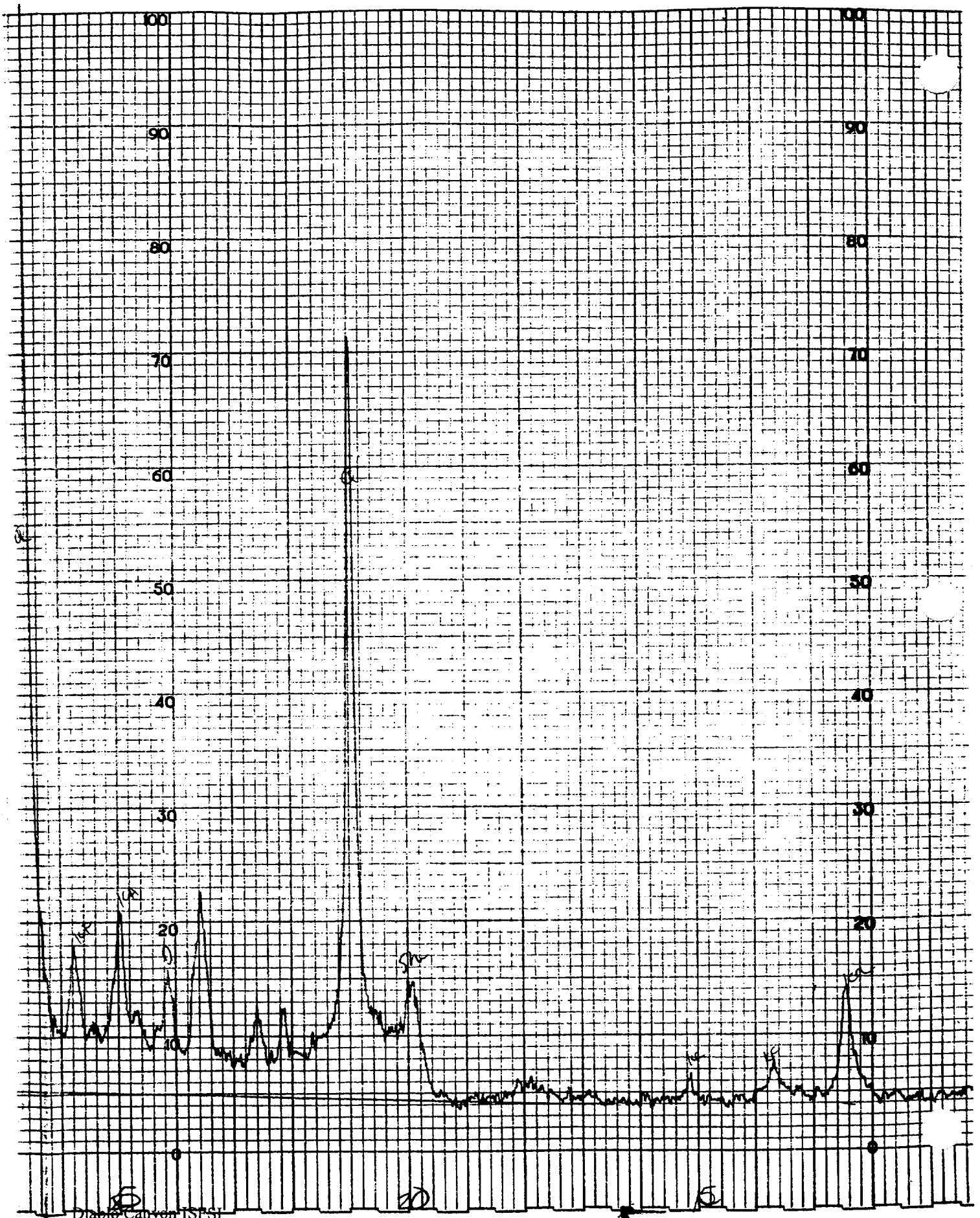

100
90
80
70
60
50
40
30
20
10
0

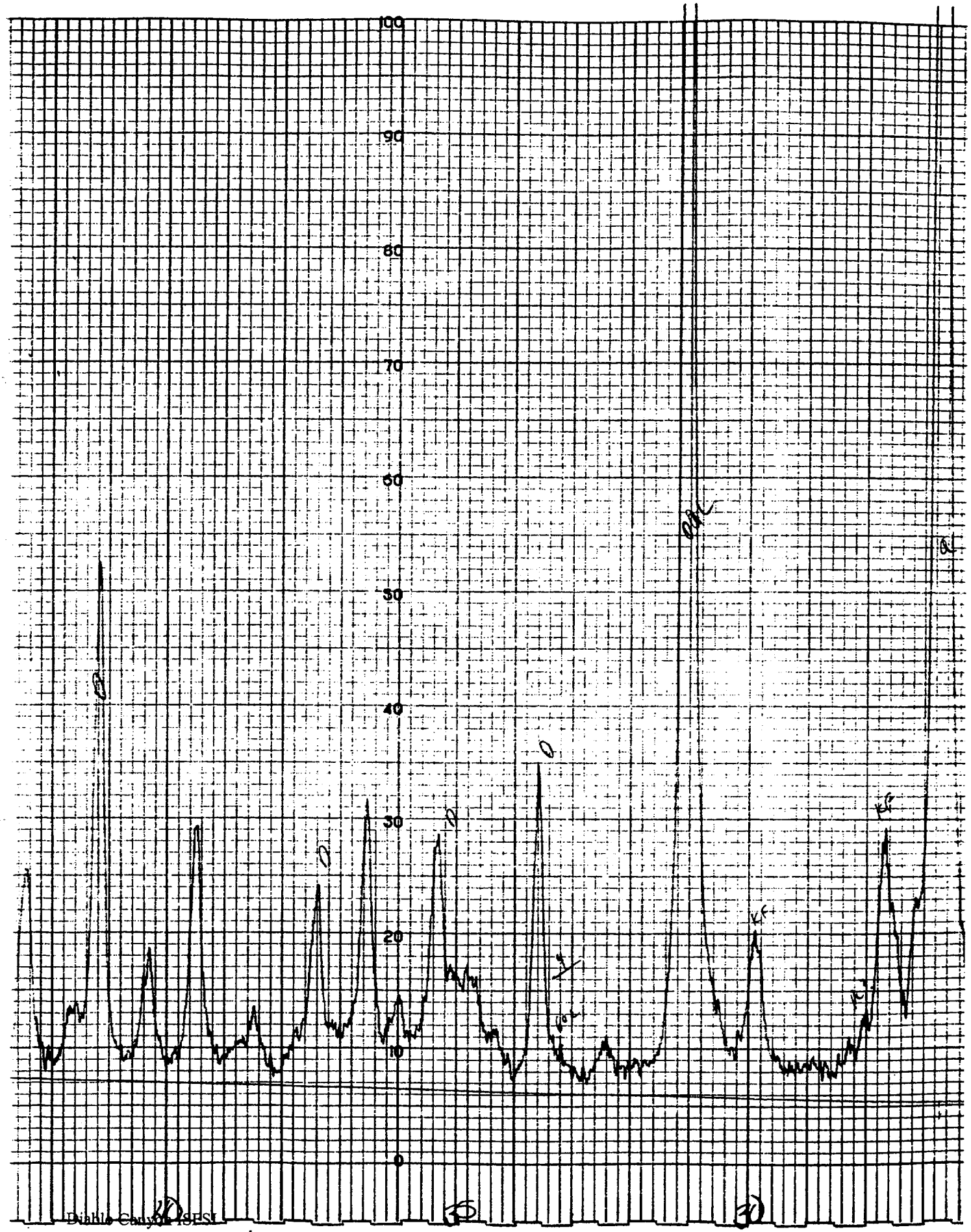

100
90
80
70
60
50
40
30
20
10
0

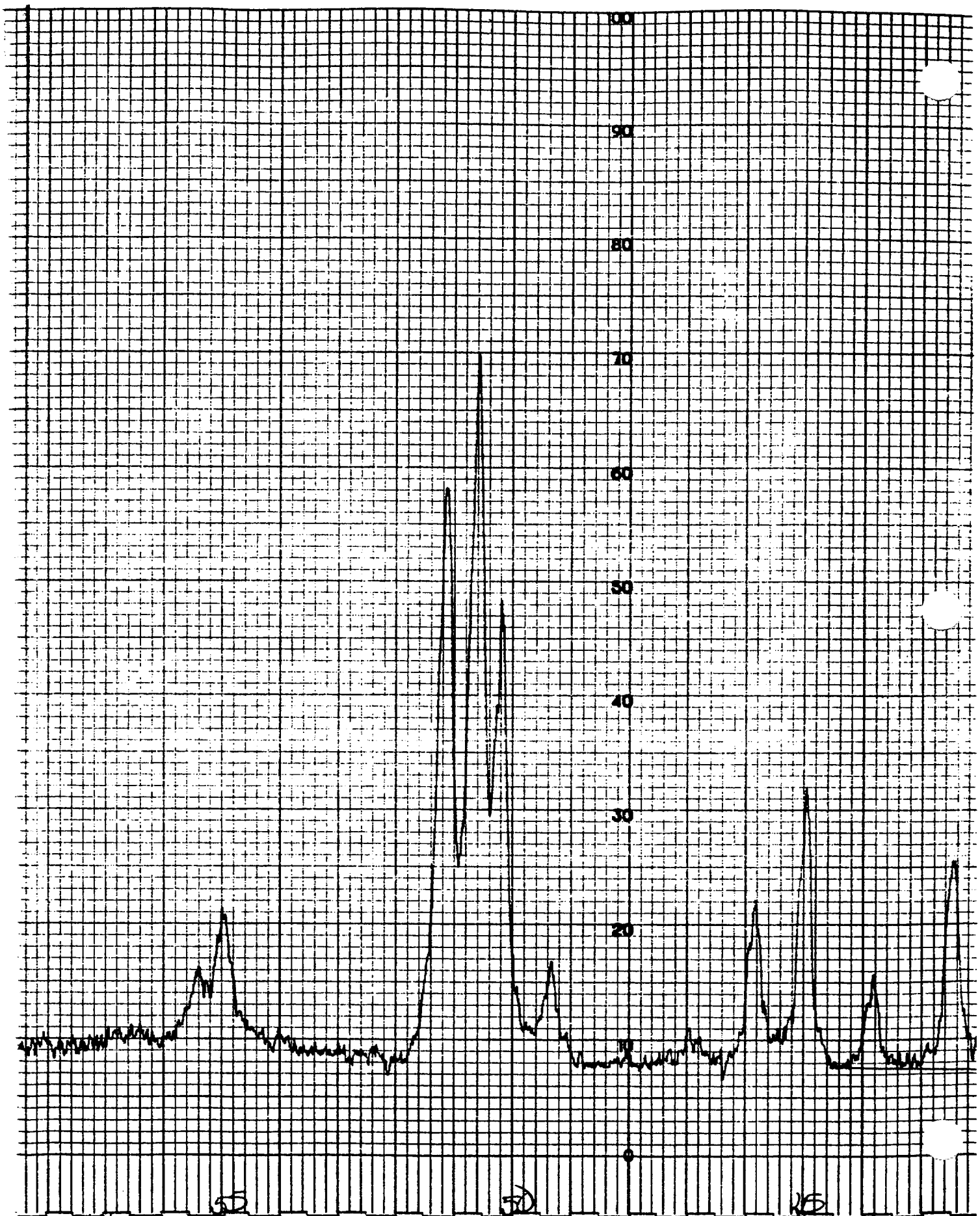

SPECTRUM PETROGRAPHICS
P-21
Bulk Glycol
100
90
80
70
60
50
40
30
20
10
0

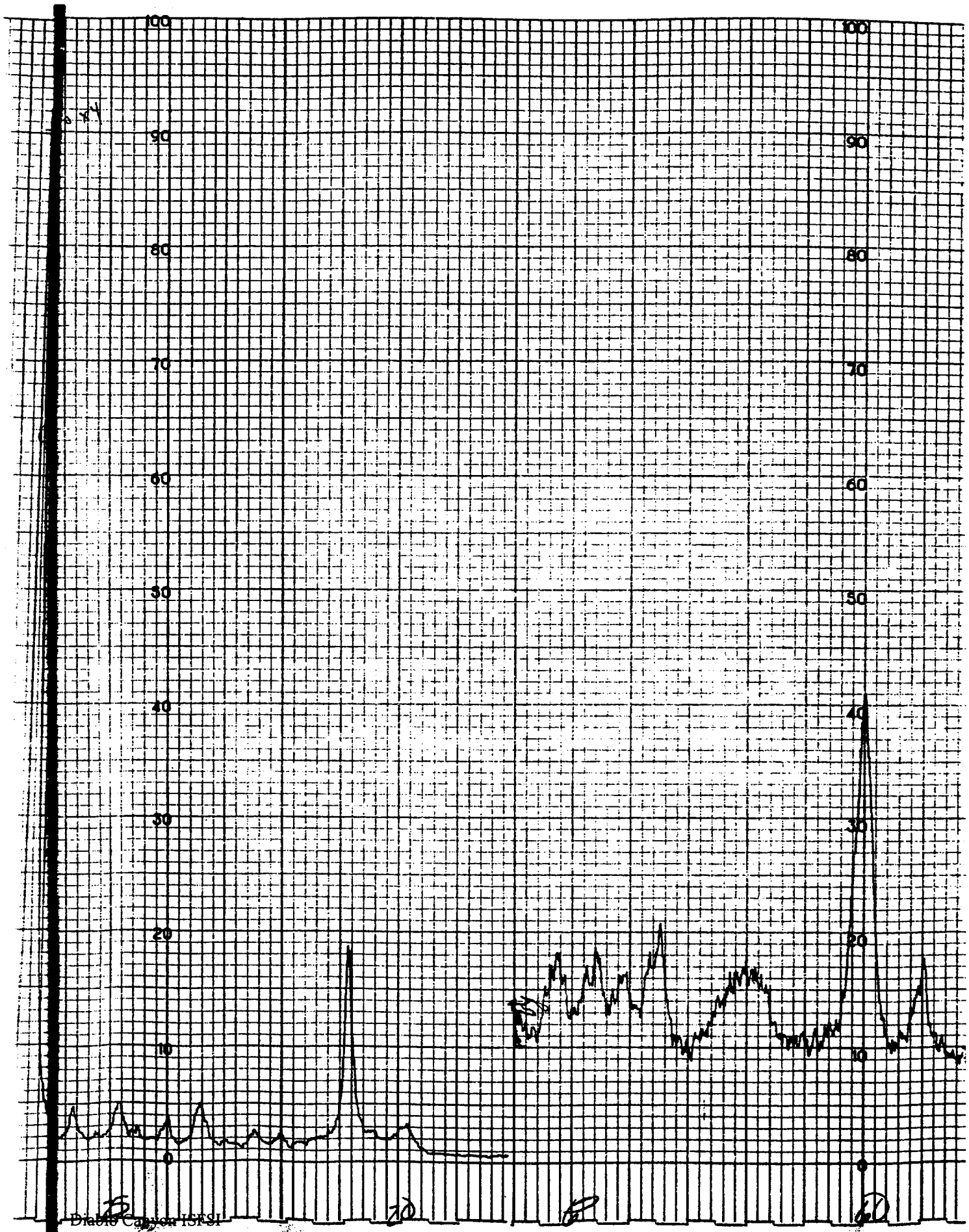

100
90
80
70
60
50
40
30
10
0
SPECTRUM PETROGRAPHICS
P-22
Bulk
C - 20
Qt - 2
Kf - 6
Poc - 33
Gof - 3
KA - 15
Sm - 31
100
Sm
147A

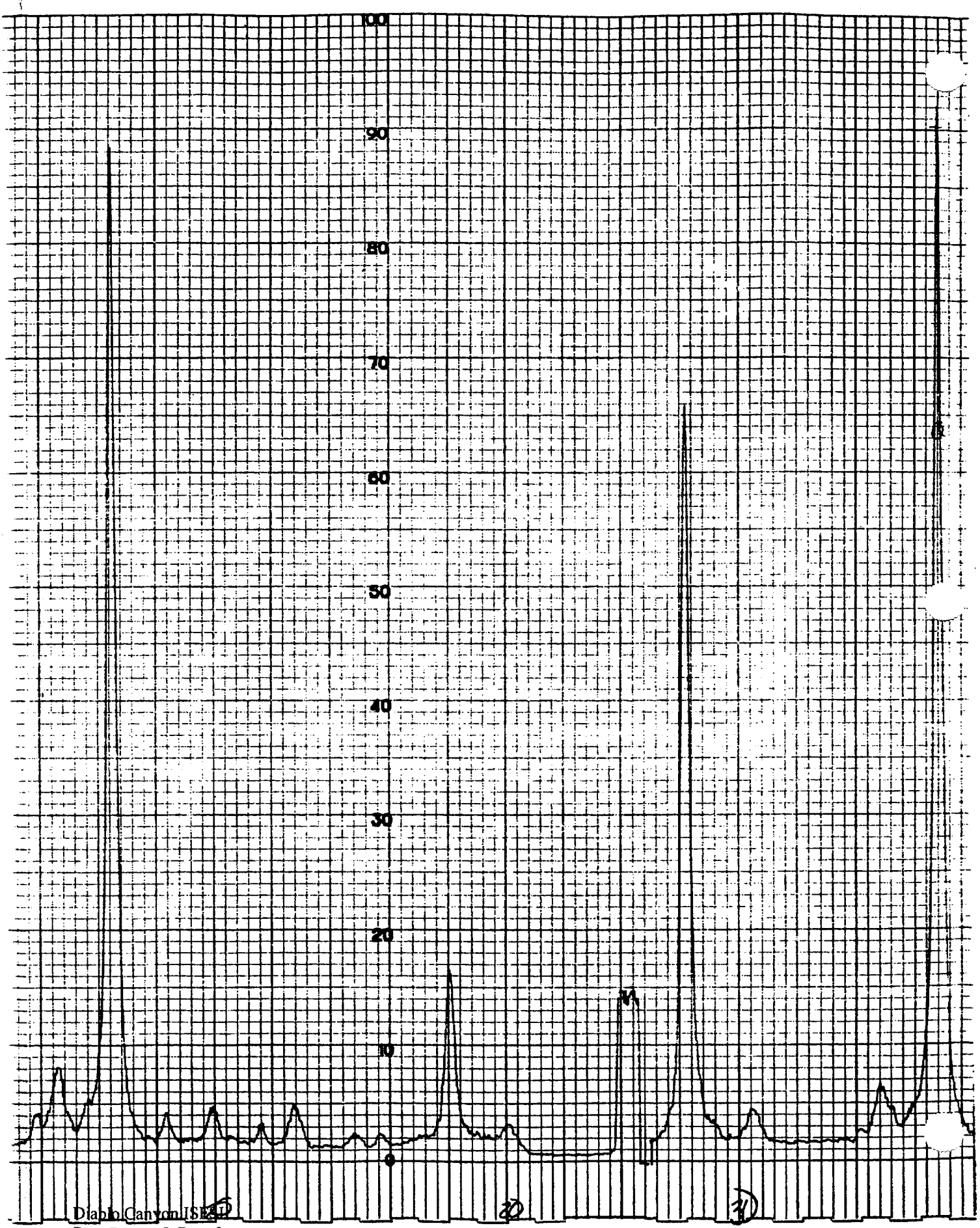

100
90
80
70
60
50
40
30
20
10
0

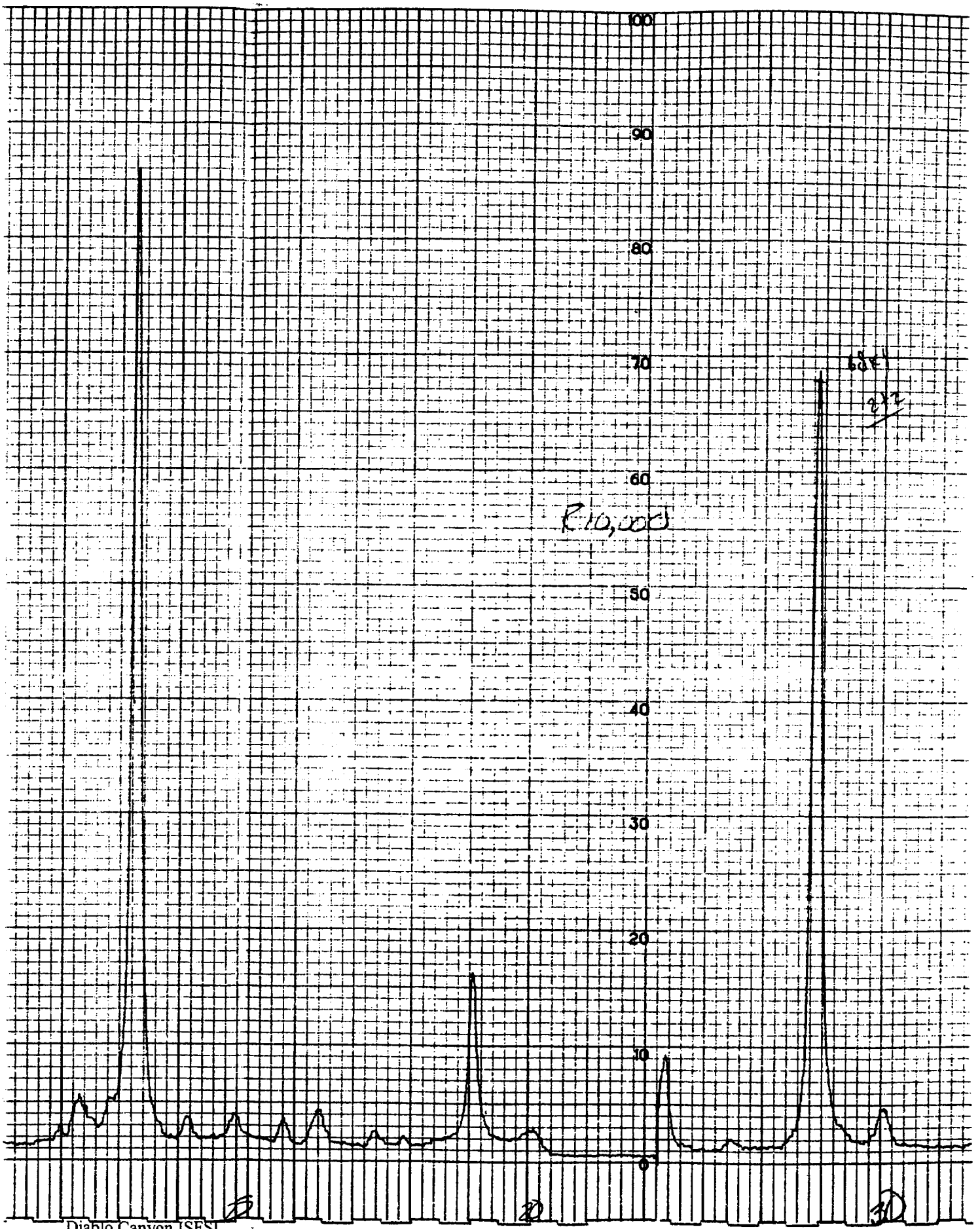

100
90
80
70
60
50
40
30
20
10
0

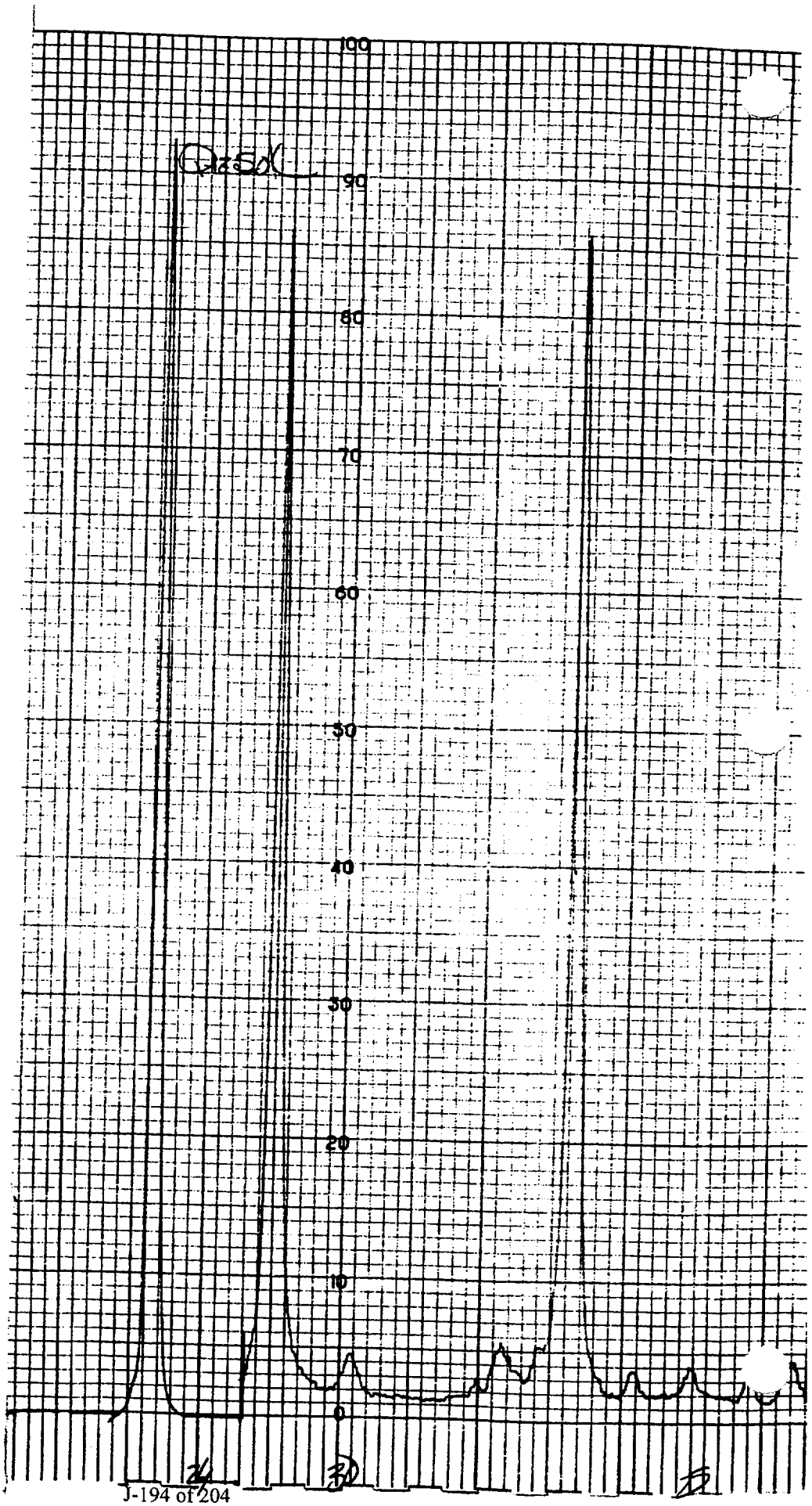

100
90
80
70
60
50
40
30
20
10
0

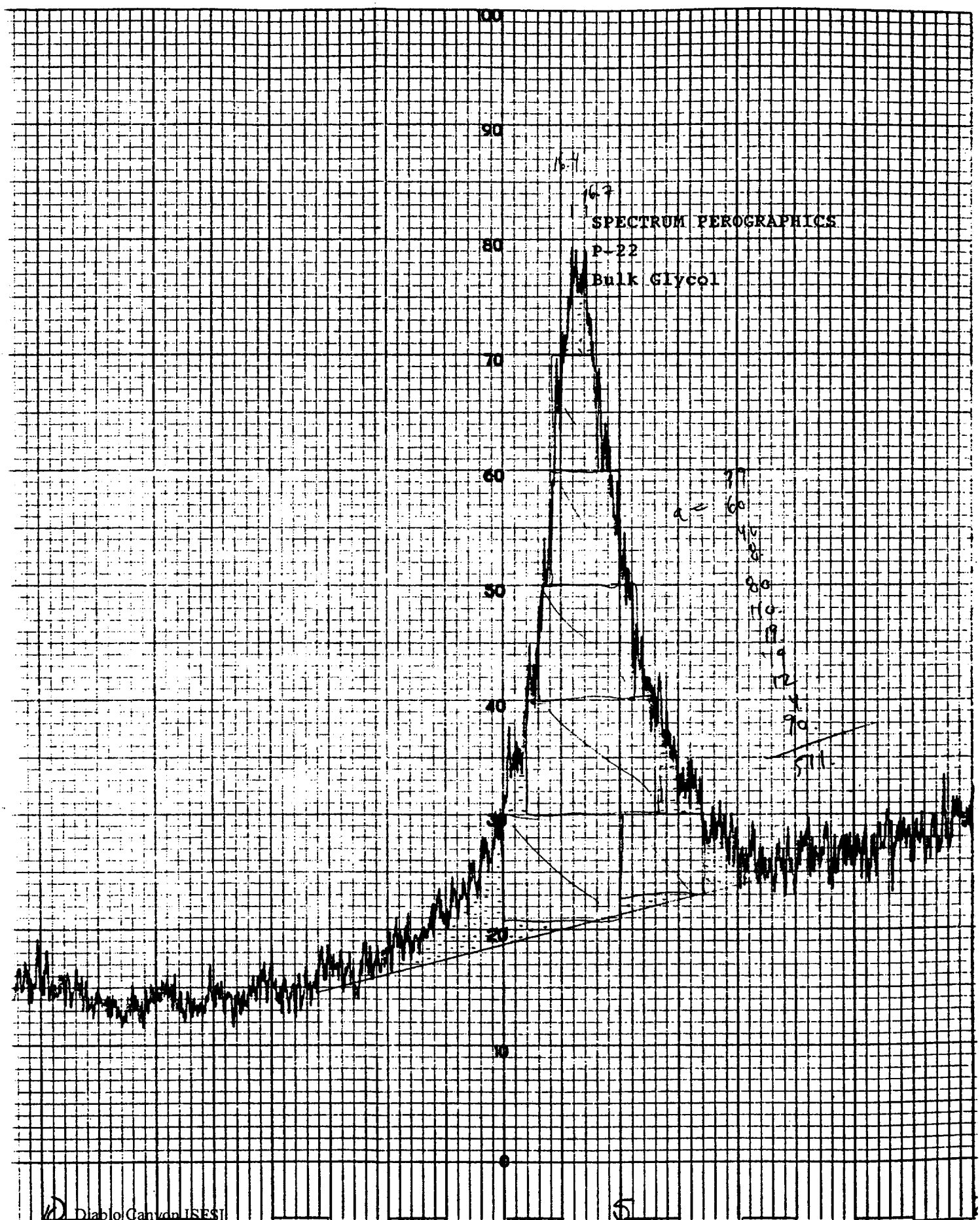

100
90
80
70
60
50
40
30
20
10
0
55
50
45

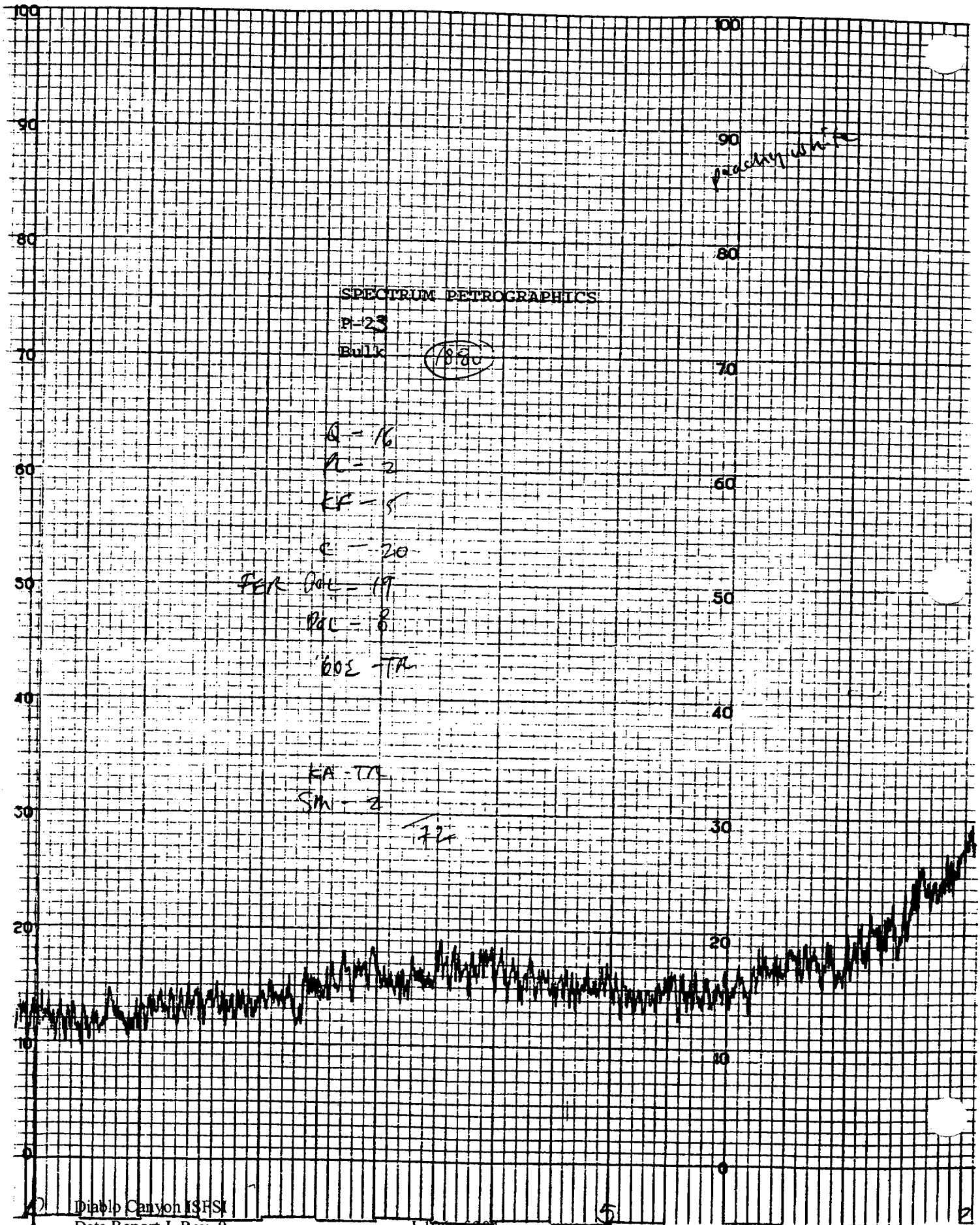

100
90
80
70
60
50
40
30
20
10
0

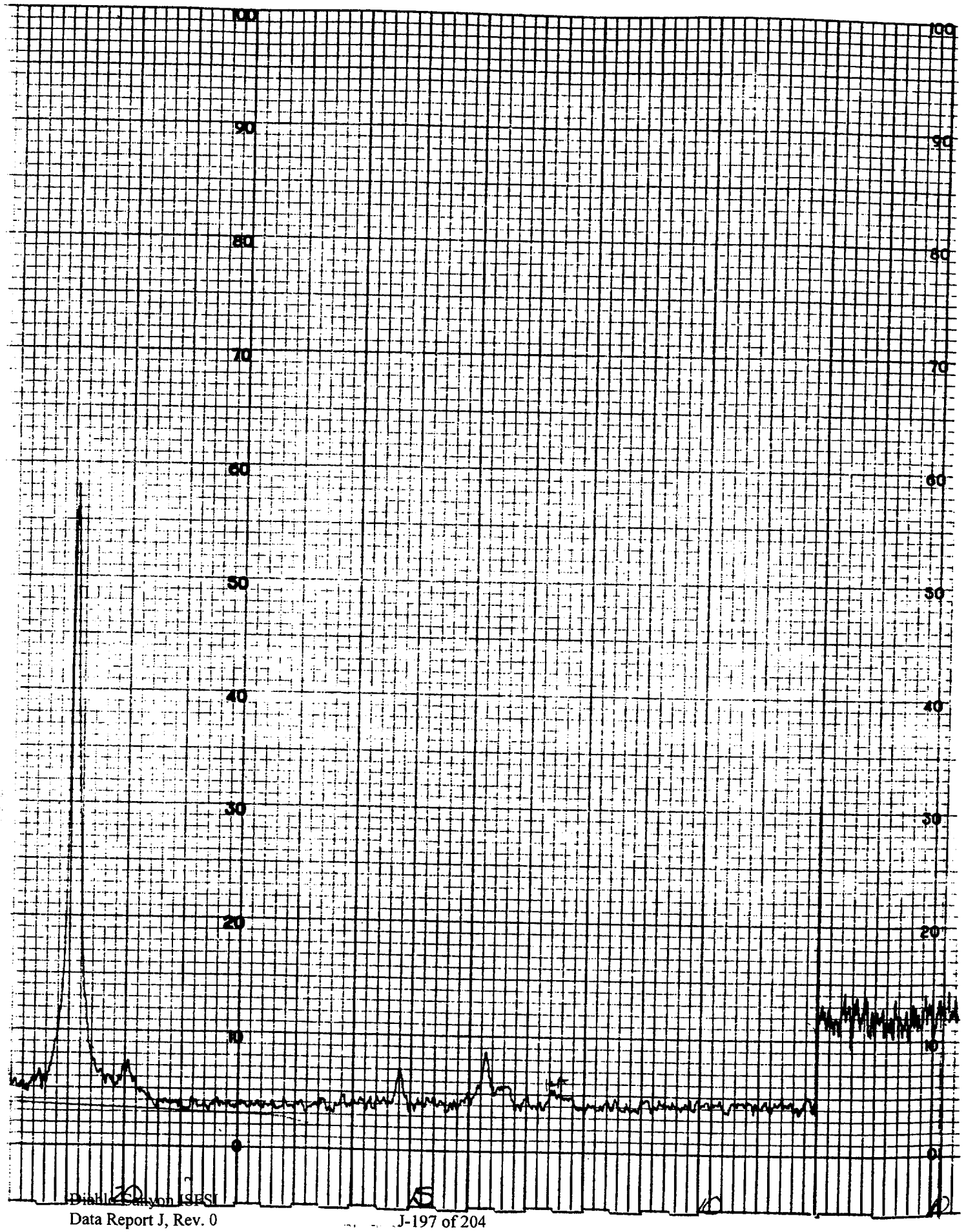

100
90
80
70
60
50
40
30
20
10
0

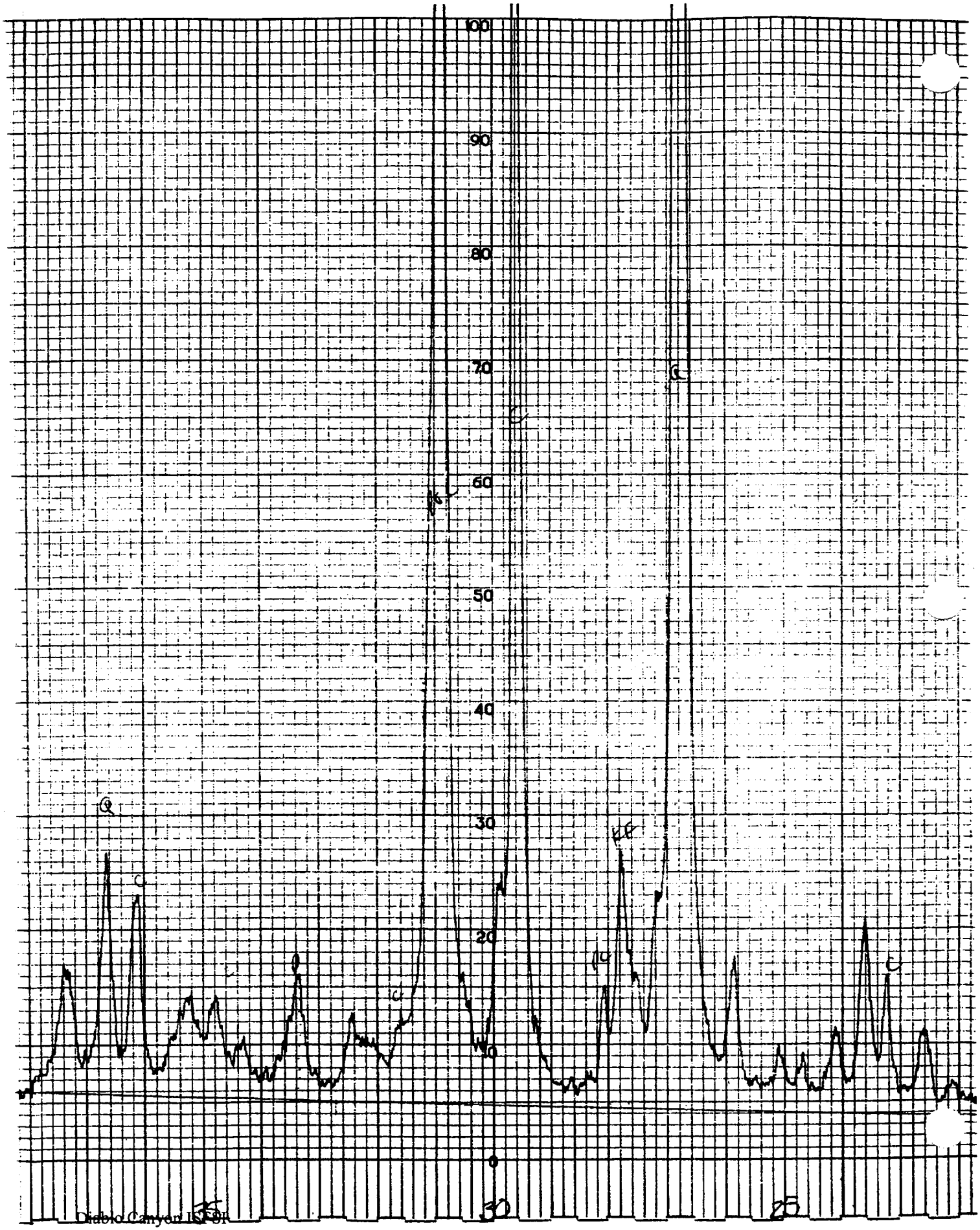

100
90
80
70
60
50
40
30
20
10
0
R10,000

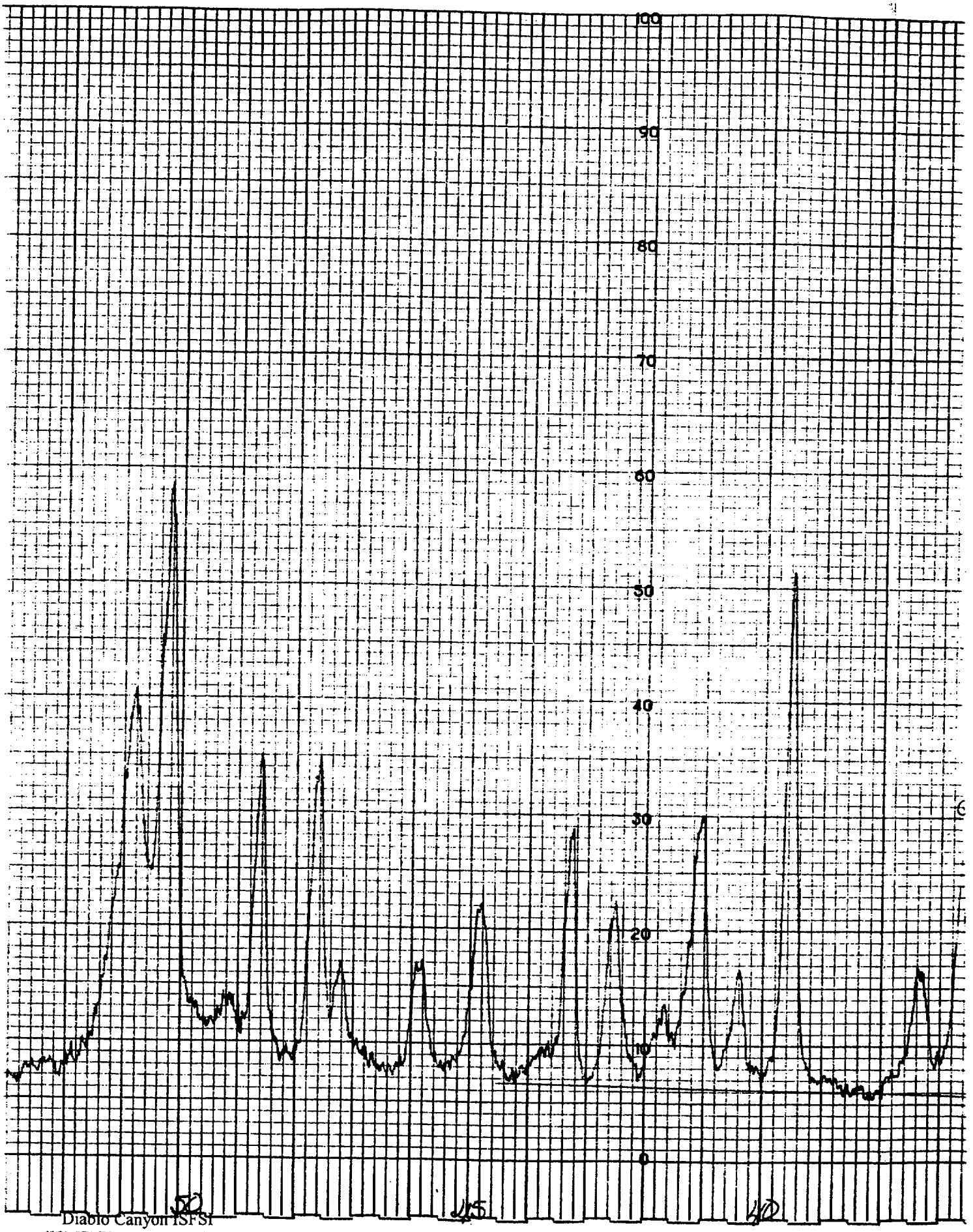

100
90
80
70
60
50
40
30
20
10
0
24
30

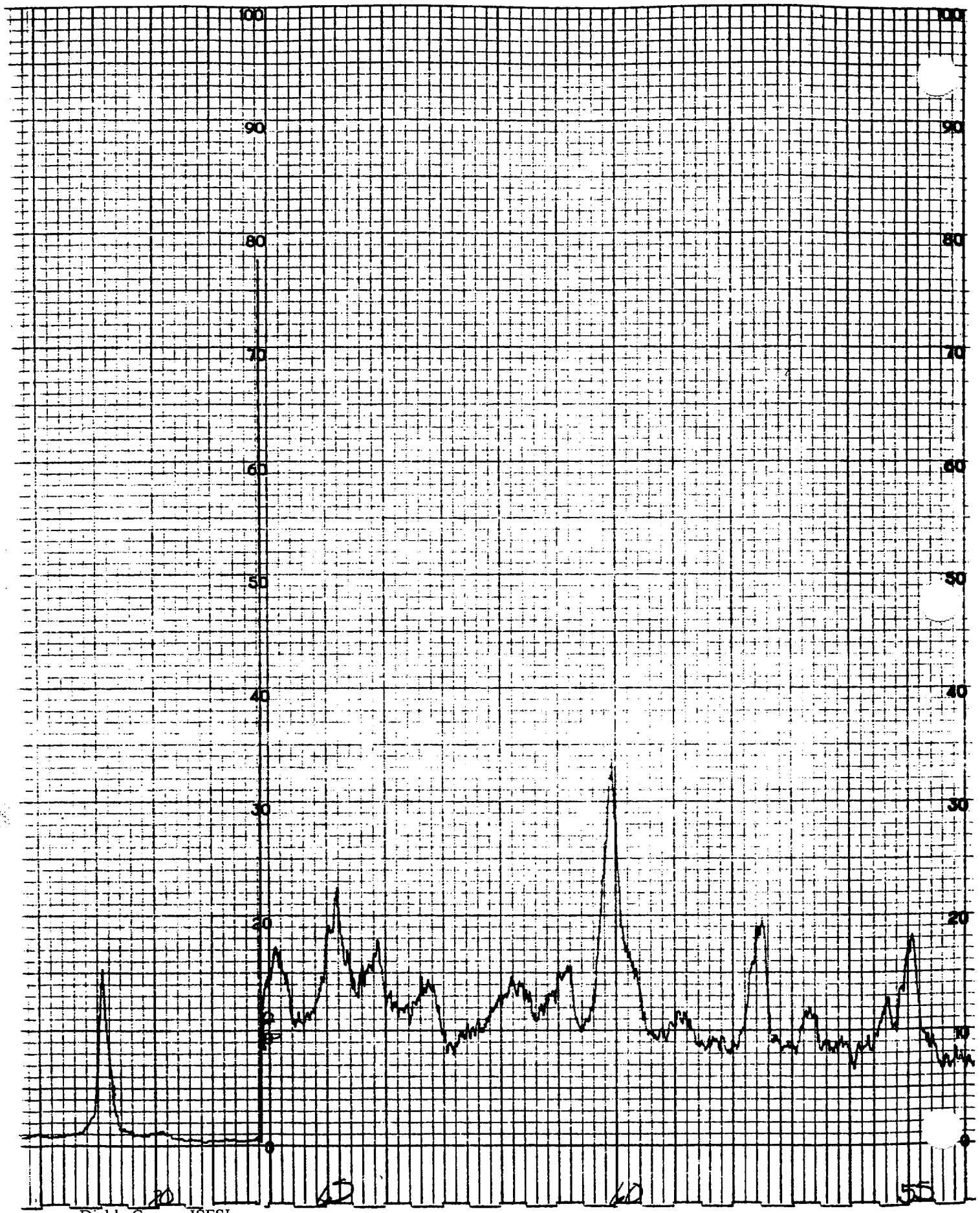

SPECTRUM PEROGRAPHICS
P-22
Bulk Glycol
100
90
80
70
60
50
40
30
20
10
0

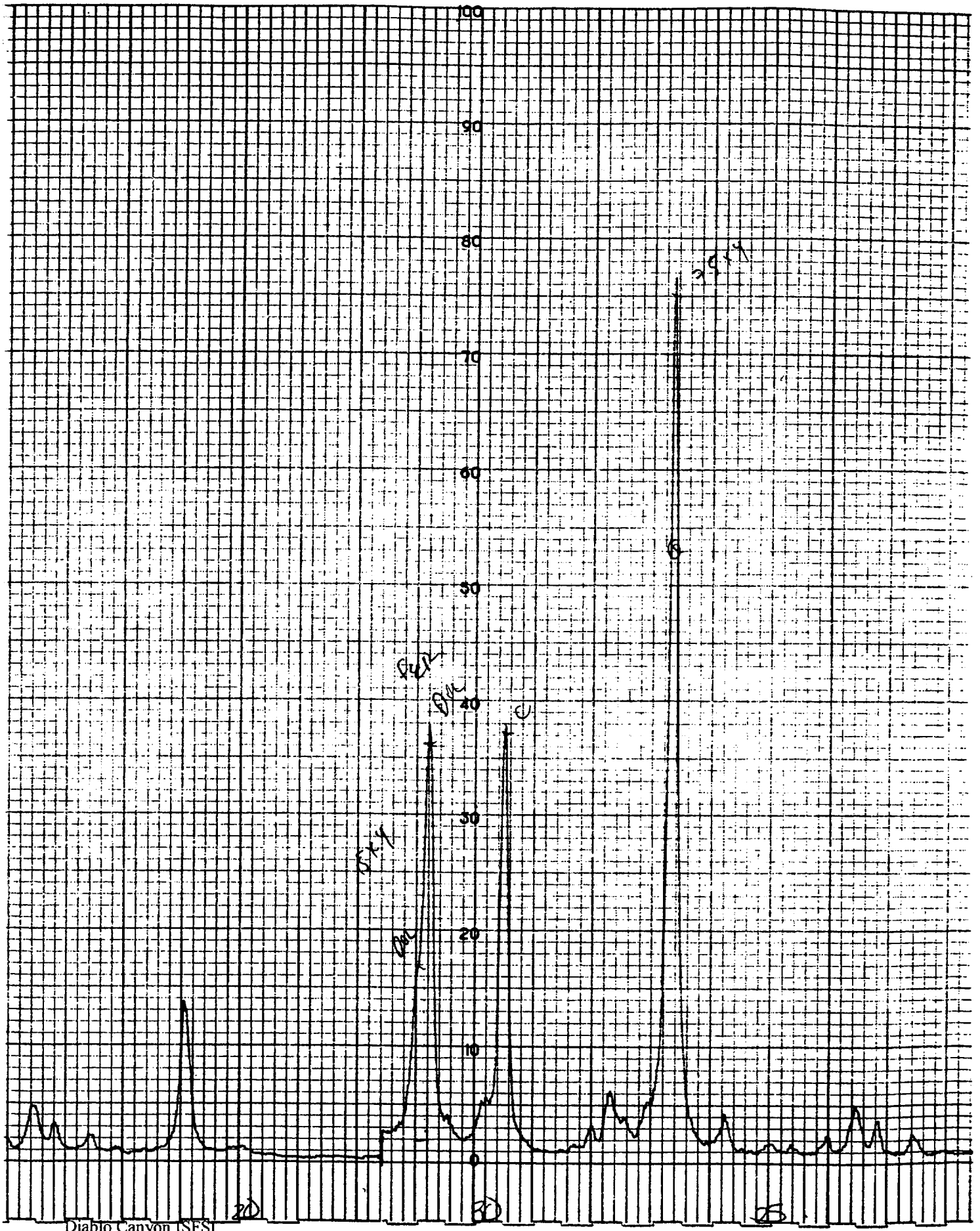

100
90
80
70
60
50
40
30
20
10
0
SPECTRUM PETROGRAPHICS
P-23
Bulk
Q - 16
M - 2
KF - 5
C - 20
FOR CAL - 19
PAL - 8
BOE - TR
EA - TR
SM - 2
72

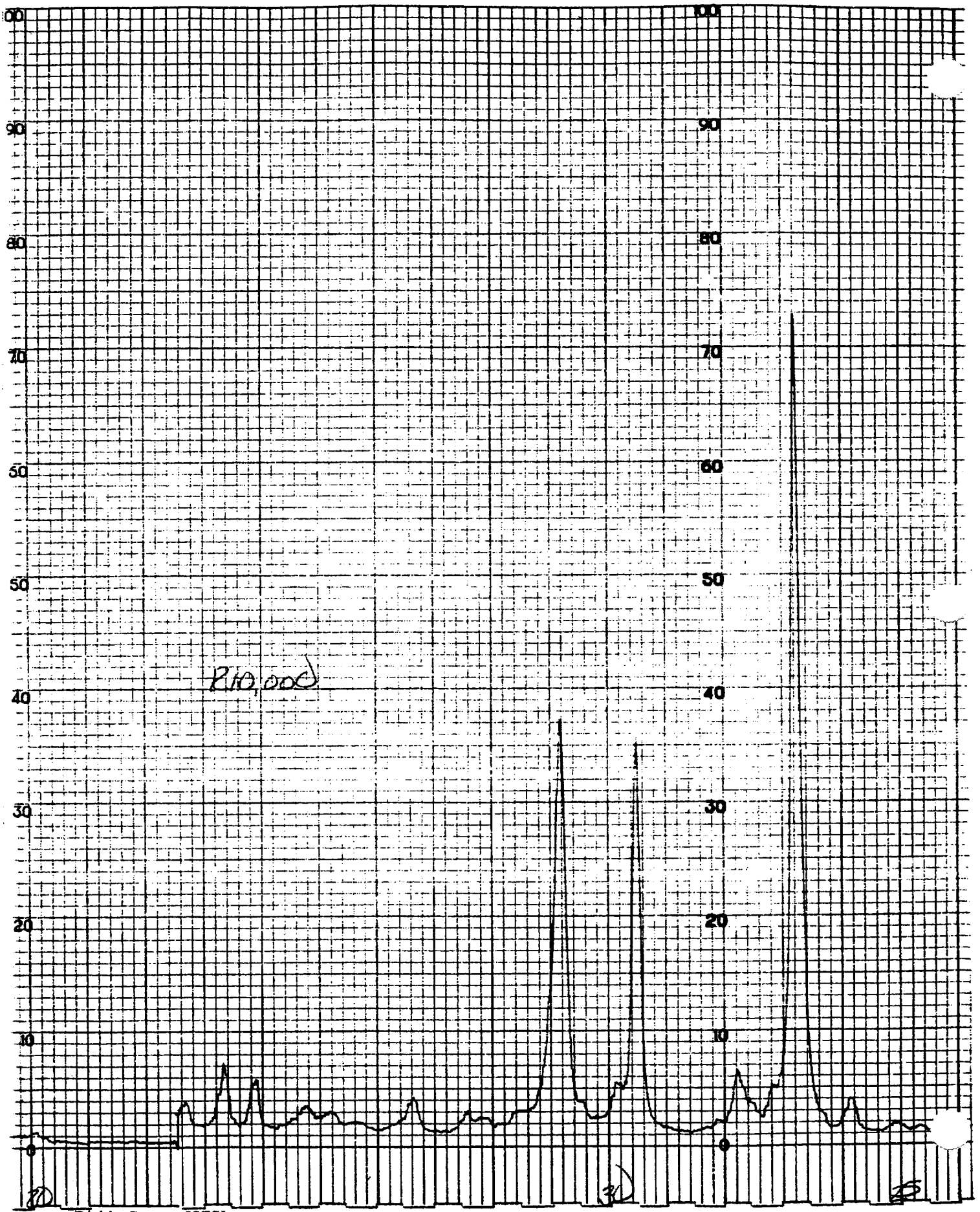

100
90
80
70
60
50
40
30
20
10
0

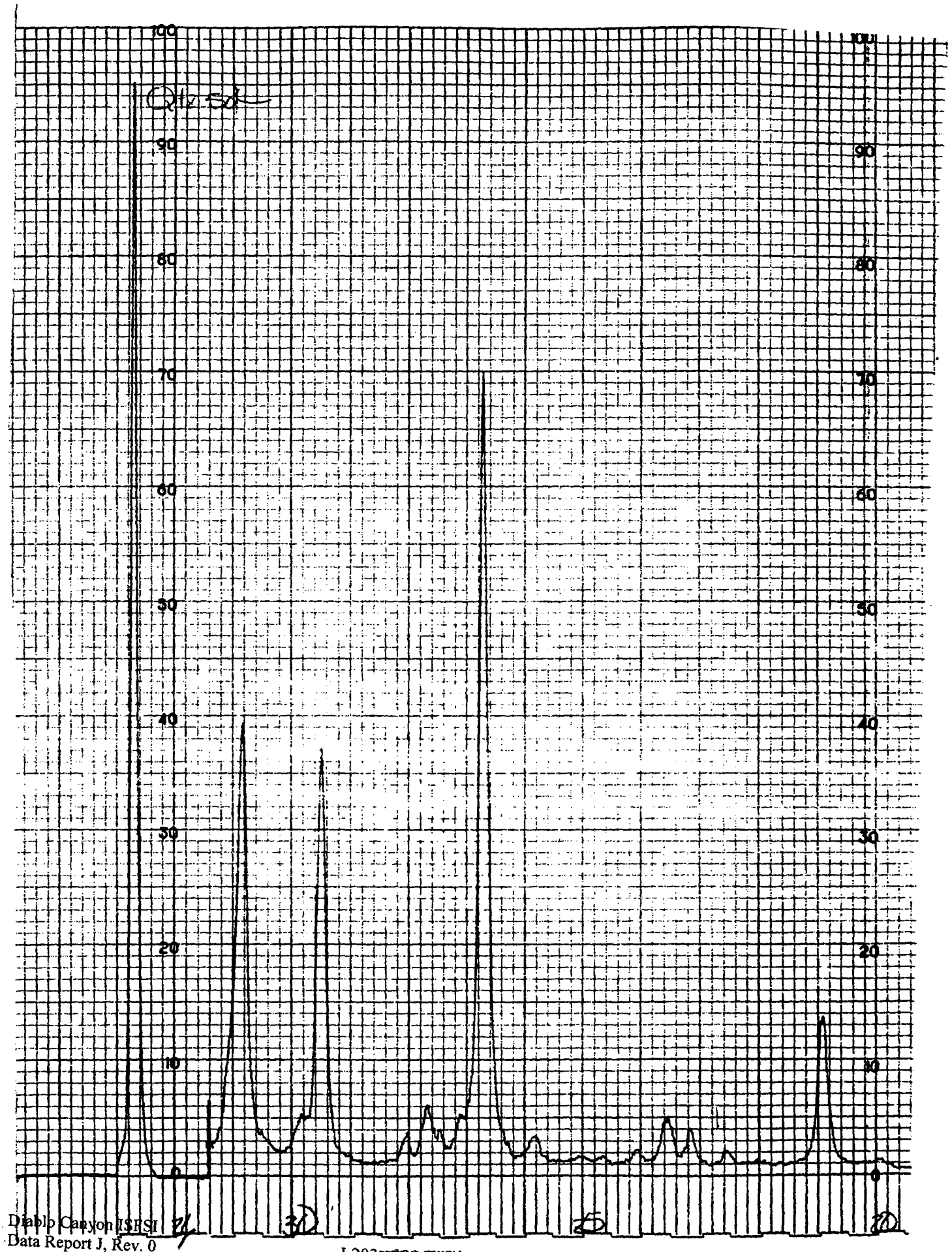

100
90
80
70
60
50
40
30
20
10
0
10
20

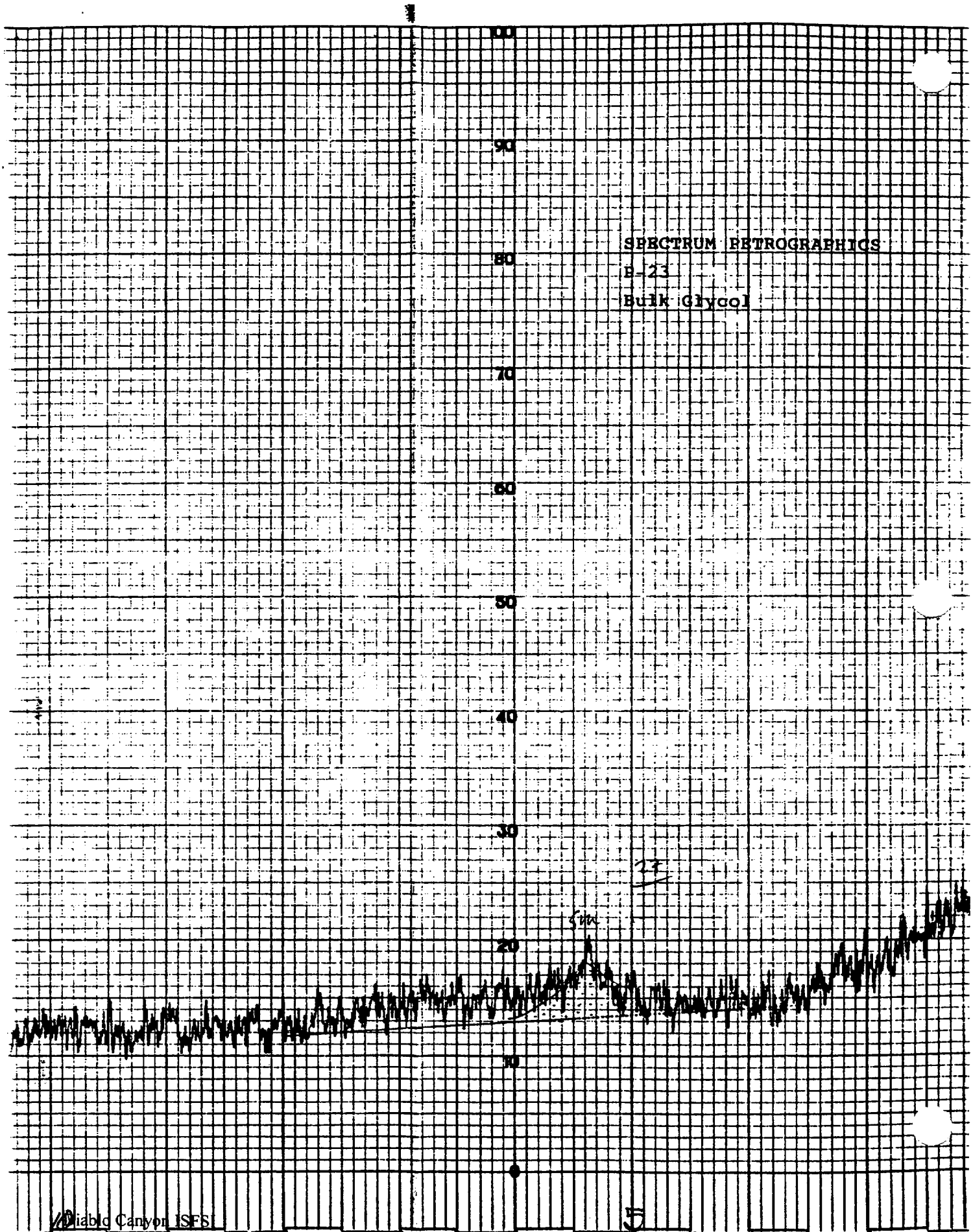

100
90
80
70
60
50
40
30
20
10
0
50
45
40


100
90
80
70
60
50
40
30
20
10
0
20
40
60
55


100
90
80
70
60
50
40
30
20
10
0
20
30
25


100
90
80
70
60
50
40
30
20
10
0
R10,000


100
90
80
70
60
50
40
30
20
10
0


100
90
80
70
60
50
40
30
20
10
0
SPECTRUM PETROGRAPHICS
B-23
Bulk Glycol
23
5m

DATA REPORT K
PETROGRAPHIC AND X-RAY DIFFRACTION ANALYSES OF CLAY BEDS (SCHWEIN/CHRISTENSEN LABORATORIES, INC.) DIABLO CANYON ISFSI

PREPARED BY		DATE	11/5/01
	Jeff L. Bachhuber		William Lettis & Associates, Inc.
	Printed Name		Organization
VERIFIED BY		DATE	11/5/01
	Scott C. Lindvall		William Lettis & Associates, Inc.
	Printed Name		Organization
APPROVED BY		DATE	11/5/01.
	William D. Page		PG&E Geosciences Dept.
	Printed Name		Organization

REGISTERED GEOLOGIST
JEFF BACHHUBER
4909
STATE OF CALIFORNIA

DATA REPORT K

PETROGRAPHIC AND X-RAY DIFFRACTION ANALYSES OF CLAY BEDS (SCHWEIN/CHRISTENSEN LABORATORIES, INC.) DIABLO CANYON ISFSI

Table of Contents

		Page
1.0	Introduction	K-3
2.0	Methodology	K-3
3.0	Results	K-4
4.0	References	K-4

List of Figures

Figure K-1 Location of clay bed samples submitted for x-ray diffraction analysis.

List of Attachments

Attachment 1 Schwein/Christensen Laboratories, Inc. Report titled "Petrographic Analyses Diablo Canyon ISFI Borrow site Samples", October 10, 2000.

DATA REPORT K
PETROGRAPHIC AND X-RAY DIFFRACTION ANALYSES OF CLAY BEDS (SCHWEIN/CHRISTENSEN LABORATORIES, INC.) DIABLO CANYON ISFSI

1.0 INTRODUCTION

Schwein/Christensen Laboratories, Inc. (SCL) provided petrographic and X-ray diffraction (XRD) analyses of four clay samples from trenches T-11A, T-14A, T-14B, and T-15 in the ISFSI site area (Figure K-1). These trenches are described in Diablo Canyon ISFSI Data Report D. The composition of the samples was originally analyzed by Spectrum Petrographics, Inc., and these results are in Diablo Canyon ISFSI Data Report J; however, the methods employed by Spectrum did not identify the specific clay minerology of the samples. The subsequent analyses by SCL described in this data report were used to identify the clay minerology, and therefore, better characterize the properties of the clay, particularly with respect to the analysis of potential slope stability. The report prepared by SCL is included in this Data Report. The samples were collected by Jeff Bachhuber of William Lettis and Associates (WLA). They were selected to cover several different clay beds to help in the analysis of the origin, and subsequent change from diagenesis, weathering, and alteration and movements. Knowing the types of clay is important in understanding their strengths.

The preparation of this data report was performed under the WLA Work Plan (Rev. 2) dated November 28, 2000.

2.0 METHODOLOGY

SCL performed three XRD analyses for each clay sample as described in the attached report. These analyses consisted of: (1) an analysis of suspended, centrifuged material; (2) an analysis of suspended material that underwent heating or glycol solvation; and (3) an analysis of silt-sized material.

SCL also conducted petrographic analyses of the clay samples using a polarizing light microscope to assess microstructural characteristics and to help with identification of the mineralogical composition of the specimen.

3.0 RESULTS

The results of the analyses by SCL include three XRD spectra for each clay sample, and sixteen digital images showing various petrographic characteristics of the clay samples. XRD and petrographic analyses performed by SCL identified sepiolite and kaolinite as the primary clay constituents of the samples, with siliceous sand and silt constituting the coarser fraction of the samples. SCL also noted common secondary calcite and dolomite mineralization as well as zeolite formation in samples X-1 and X-2.

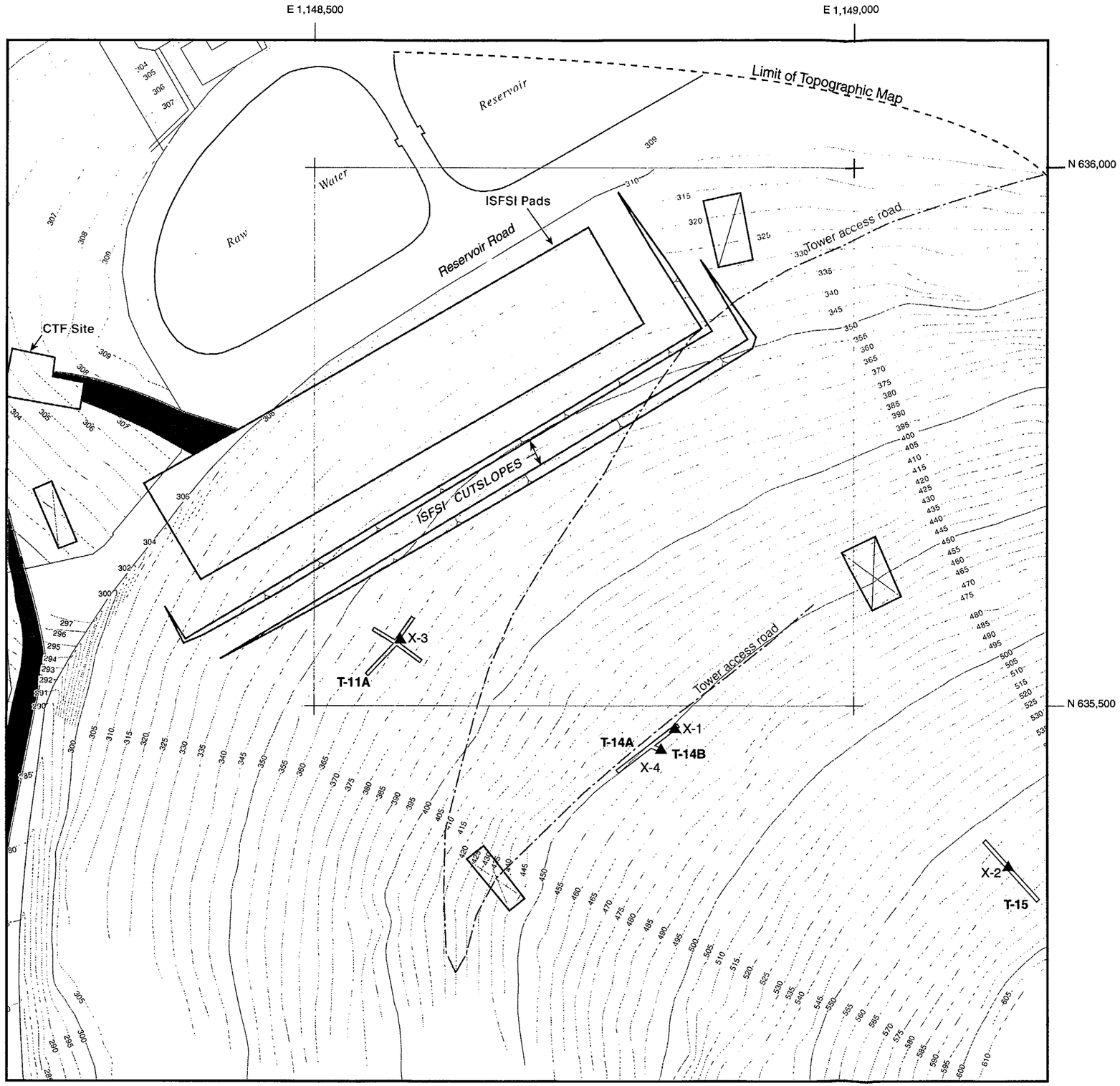
Petrographic examination of soil fabrics showed evidence for moderate reworking and alteration by ground or hydrothermal water. Alteration, commonly expressed as iron oxide, developed predominantly along fractures. SCL found no evidence for cataclastic textures in any of the samples

4.0 REFERENCES

Diablo Canyon ISFSI Data Report D, Trenches in the ISFSI Site Area, prepared by William Lettis & Associates, Inc., November 5, 2001, 66 pp.

Diablo Canyon ISFSI Data Report J, Petrographic Analysis and X-Ray Diffraction of Rock Samples (Spectrum Petrographics, Inc.), prepared by William Lettis & Associates, Inc., November 5, 2001, 204 pp.

William Lettis & Associates Work Plan, Additional Geologic Mapping, Exploratory Drilling, and completion of kinematic Analyses for the Diablo Canyon Power Plant, Independent Spent Fuel Storage Installation Site, Rev. 3, November 28, 2000.



EXPLANATION

Footprint of 500 kV tower

Outline of ISFSI Pads

X-1 ▲ X-ray diffraction clay bed sample location, sample numbers correspond to Schwein Christianson Laboratories (SCL) Sample Numbers

N

0 50 100 150 200

Contour interval = 5 feet

SAFETY ANALYSIS REPORT

DIABLO CANYON ISFSI

FIGURE K-1
LOCATION OF CLAY BED SAMPLES SUBMITTED FOR X-RAY DIFFRACTION ANALYSIS

ATTACHMENT 1

DATA REPORT K

SCHWEIN/CHRISTENSEN LABORATORIES, INC. REPORT TITLED "PETROGRAPHIC ANALYSES DIABLO CANYON ISFSI BORROW SITE SAMPLES" OCTOBER 10, 2000.

SCL

SCHWEIN/CHRISTENSEN
LABORATORIES, INC.

materials consulting
laboratory testing
failure analysis

October 10, 2000

SCL Project No.00211

Mr. Jeff Bachhuber
William Lettis & Associates
1777 Botelho Drive, Suite 262
Walnut Creek, CA 94596

Subject: Petrographic Analysis
Diablo Canyon ISFSI Borrow Site Samples

Dear Mr. Bachhuber:

Schwein/Christensen Laboratories, Inc. (SCL) has examined the soil samples that you provided to us from the above-referenced project. According to your transmittal letter dated August 22, 2000 a petrographic examination on each clay was requested to determine the type of clay minerals present.

SAMPLE IDENTIFICATION

Table 1 lists the samples delivered by Mr. Jeff Bachhuber of WLA:

TABLE 1. Sample Identification

No.	Lab. No.	Description
1	X-1	Bag, Clay Seam Sample, "Map St. 00-35, Upper Tower Rd. Trench (T-14A)"
2	X-2	Bag, Clay Seam Sample, "ISFSI Trench T-15, St. 8+40 @ 0.5m"
3	X-3	Bag, Clay Seam Sample, "DCPP ISFSI Trench T-11A, S-4, Split B, St. 10+00"
4	X-4	Bag, Clay Seam Sample, "DCPP ISFSI Trench T-14B, Backhoe Cutting Split B"

PROCEDURES

X-ray Diffraction Analysis

X-ray diffraction analysis (XRD) determines the compound composition of the material.

3397 Mt. Diablo Blvd., Suite E, Lafayette, CA 94549 Tel: (925) 284-3311 Fax: (925) 284-3360

X-ray Diffraction provides qualitative crystalline compound analysis of materials by exposing a powdered sample to x-ray radiation. The characteristic x-ray pattern is compared to the International Centre for Diffraction Data (ICDD) powder diffraction file computer database of crystalline reference materials. A silicon standard, supplied by Rigaku International Corporation is periodically run to check the equipment calibration. The spectrum for the silicon standard is provided upon request. XRD can normally detect compounds at concentrations as low as approximately 2% by weight of sample. The results of this analysis are qualitative and indicate relative amounts of the compounds present.

The soil samples were mixed with distilled water to separate the clay fraction from the silt, sand and gravel components. A dispersive agent was added to the water to facilitate the separation. The suspended material was immediately decanted and allowed to settle for 10 minutes, after which a pipet was used to remove some of the suspension. The suspension was then centrifuged for 10 minutes to remove any remaining silt particles. The suspension was vacuum deposited onto ceramic discs and allowed to air dry. The settle material was washed between the #100 and #200 U.S. sieves and air dried.

XRD analysis was performed on the suspended material and the silt fraction of the sediment. Additional XRD analyses were performed on the suspended to further isolate and identify clay minerals. The clay suspension for X-1 and X-2 were heated in a oven at 500°C for 4 hours. This heat treatment will destroy kaolinite-clay minerals. The clay suspension for X-2 and X-3 were maintained in a glycol solvated condition for 24 hours at 60°C. Smectite clays expand when exposed to glycol, causing changes in the crystal lattice spacings. Because of the similarity of all the clay suspensions, it was not necessary to run both additional tests of each sample.

Petrographic Analysis

A petrographic examination is performed to determine the microstructural characteristics and mineralogical composition of the specimen.

A petrographic specimen is made by removing a small portion of the sample and vacuum-impregnating with clear epoxy. The specimen size is reduced to fit onto a standard petrographic glass slide and allowed to air dry on a low temperature hot plate (90°F) for approximately 3 to 5 days. After the initial preparations the specimen surface is ground on diamond impregnated grinding discs until a finely lapped surface is obtained. The lapped side is mounted on a glass slide with clear epoxy and reduced to a thickness of 30 microns. This "thin section" is then examined with a polarizing light microscope.

RESULTS

X-ray Diffraction Analysis

A summary of the XRD analysis results are given in Table 2. The relative mineral abundance decreases from left to right in the table column. The XRD spectra for the individual samples are enclosed in Figures 1 thru 8.

TABLE 2. X-ray Diffraction Analysis

Sample	Clay-size Minerals	Silt-size Minerals
X-1	Ganophyllite (zeolite), Kaolinite, Sepiolite	Quartz, Feldspar, Dolomite
X-2	Ganophyllite (zeolite), Kaolinite	Quartz, Calcite, Kaolinite
X-3	Sepiolite, Kaolinite	Dolomite, Quartz, Minrecordite, Ankerite
X-4	Sepiolite, Kaolinite	Calcite, Quartz, Dolomite, Ankerite

The heat treatment of X-1 and X-2 completely destroyed kaolinite in the sample, leaving ganophyllite and sepiolite relatively unaffected. The glycol solvation did not produce expansion in any clay minerals. Three XRD spectra are included for each soil sample (see appendix). One spectra is for the suspended, centrifuged material, the second for special treatment (heating or glycol solvation), and the third for the silt-size material. The sample name is at the upper left-hand corner of the spectra.

The test tubes shown in photos 1 thru 5 contain the suspended material after centrifuging. The clay-size material in X-1 and X-4 were still held in suspension even after approximately 1 month. X-2 had slightly less suspended material and X-3 very little.

Petrographic Analysis

Figures 1 thru 8 are digital images of the soil samples viewed in both plane polarized and cross polarized light illumination. In general the soil fabrics suggest modest localized re-working and alteration by ground water. Alteration was strongest along fractures, where iron oxide formation was common. Cataclastic textures were not evident in any of the samples.

Figures 1 and 2 are images of sample X-1, showing silt, clay, secondary calcite mineralization and iron oxide staining. Figures 3 and 4 are higher magnification views of sample X-1, showing veins of iron oxide and a brown amorphous alteration rim developing along a fracture. Secondary calcite was disseminated throughout the clayey groundmass. Photo 6 shows the petrographic thin-section mount after the specimen was cut from the glass slide. Note the amount of swelling that occurred.

Figures 5 and 6 show relict microfossils parent soil in sample X-2. Alteration products and secondary calcite had formed around small fractures. Figures 7 and 8 show crossing-cutting fractures and associated alteration rims in a wider view. The microfossils appear to be benthonic foraminifera.

Figures 9 and 10 show iron oxide formation and dolomitization in sample X-3. Figures 11 and 12 show a iron oxide staining along fractures in sample X-3.

Figures 13 and 14 are close up magnifications of microfossils in sample X-4. The fossil (foraminifera) typically were filled with calcite. Figures 15 and 16 show a wider view of sample X-4. Dolomitization had also occurred.

CONCLUSIONS

In general, the soil samples were composed of sepiolite and kaolinite clays and siliceous sands and silts. Secondary mineralization of calcite and dolomite was also common. Zeolite formation had occurred in samples X-1 and X-2.

Please call if any questions arise.

Very truly yours,

SCHWEIN/CHRISTENSEN LABORATORIES, INC.

Jon Asselanis
Materials Scientist/Petrographer

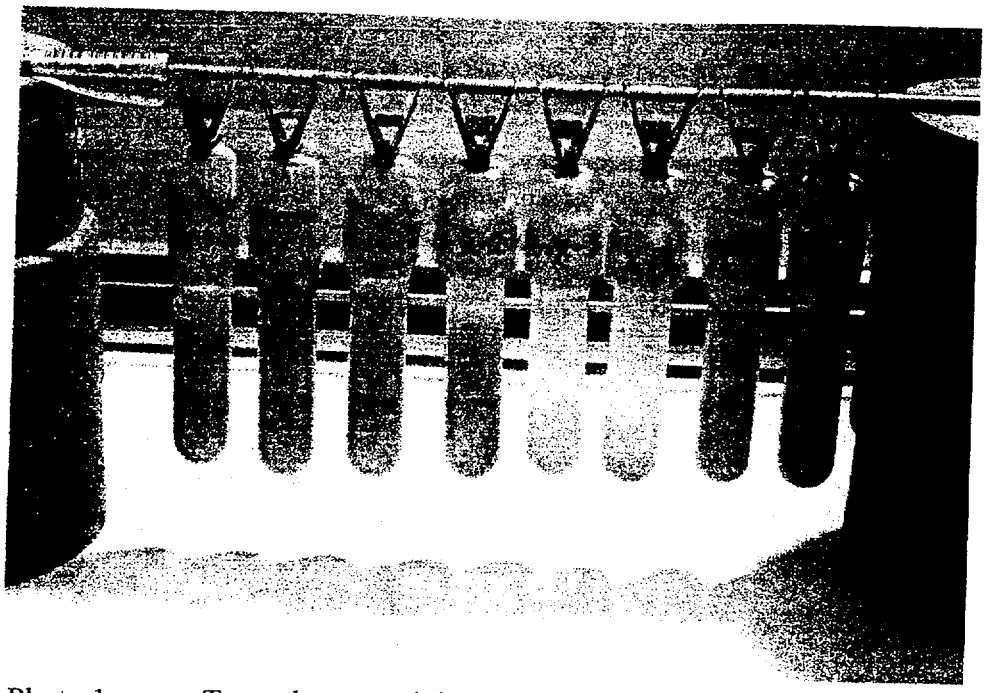


Photo 1: Test tubes containing centrifuged material from soil samples X-1 through X-4.

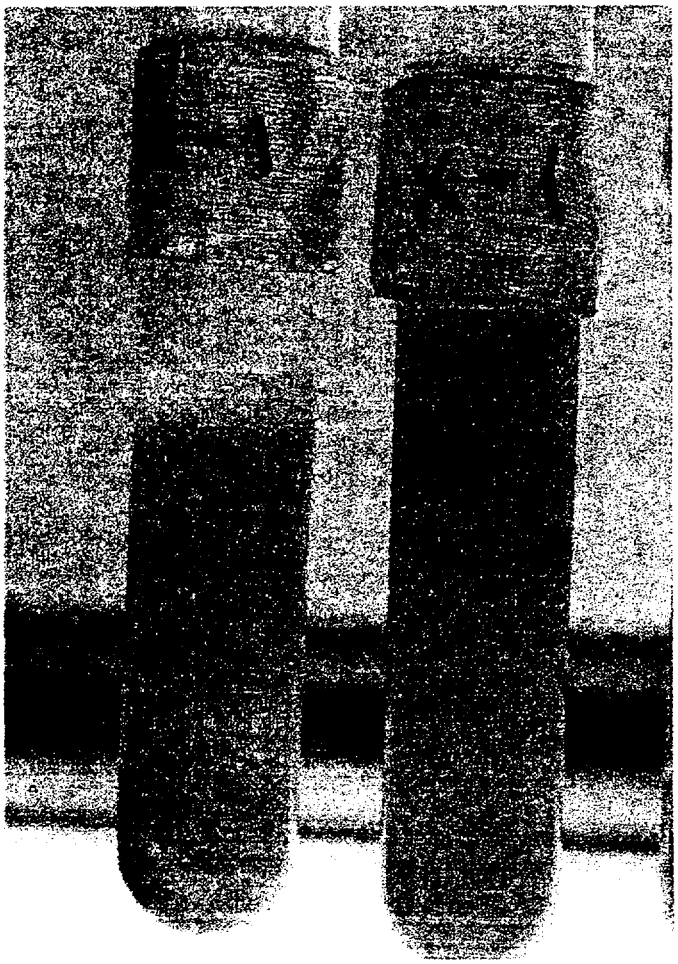


Photo 2: X-1 suspended material in test tube after resting approximately one month.

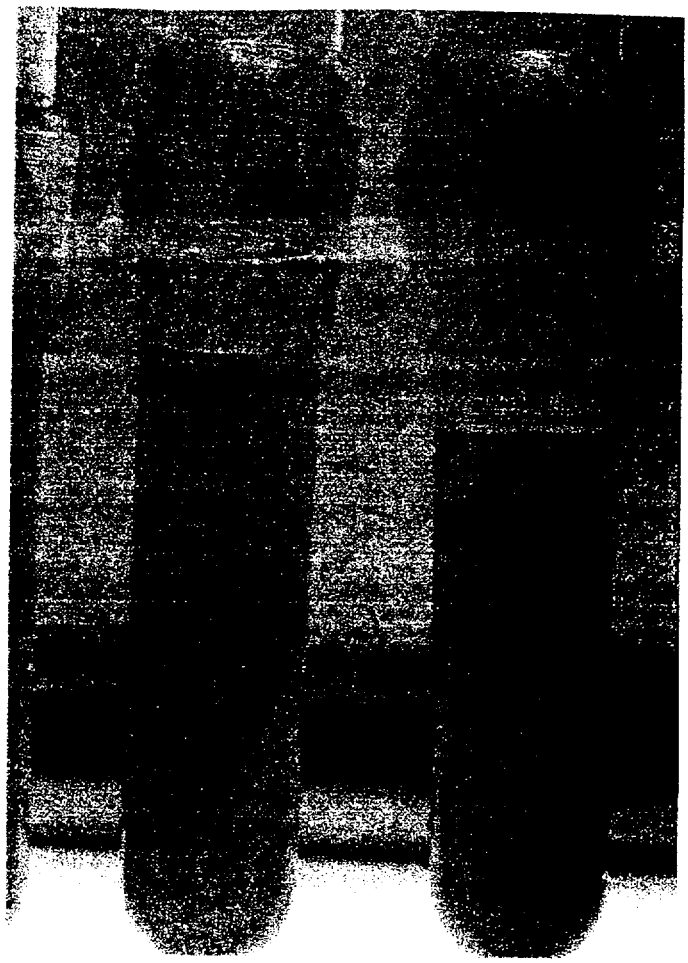


Photo 3: X-2 suspended material in test tube after resting approximately one month.

Photo 4: X-3 suspended material in test tube after resting approximately one month.

Photo 5: X-4 suspended material in test tube after resting approximately one month.

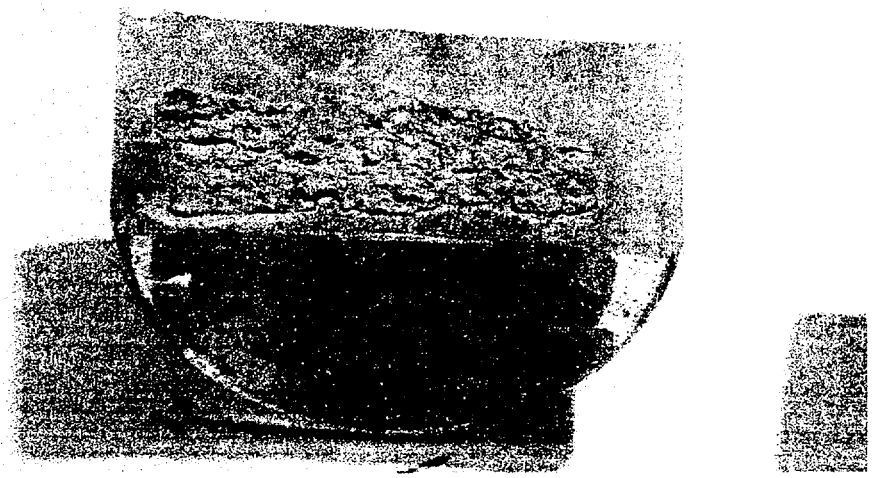


Photo 6: Swelling of Sample X-1 thin section mount after cutting.

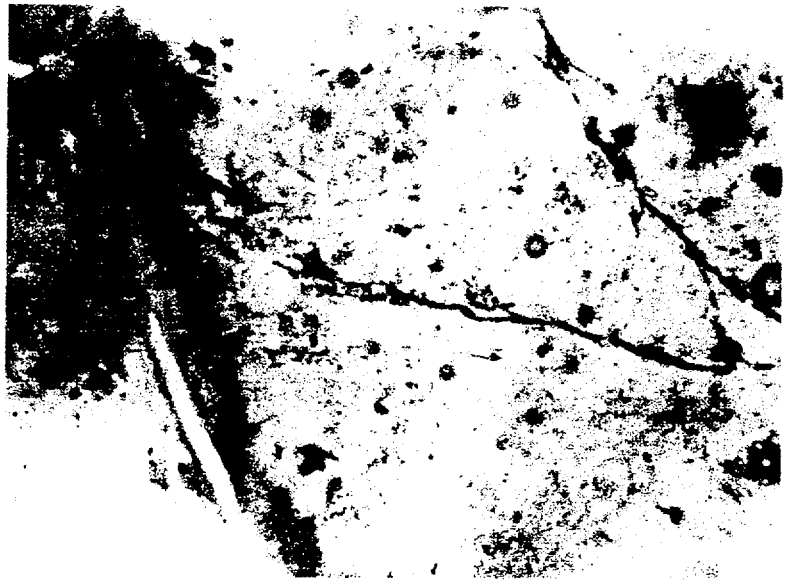


Figure 3. Thin-section of X-1 soil sample. 40x magnification, plane polarized light illumination

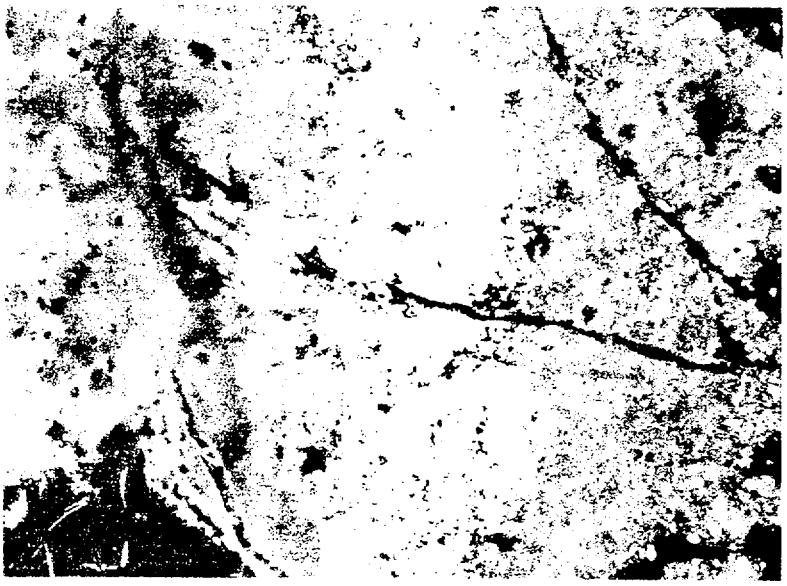


Figure 4. Same as Figure 3 except cross polarized light illumination.

Figure 5. Thin-section of X-2 soil sample. 40x magnification, plane polarized light illumination

Figure 6. Same as above except cross polarized light illumination

Figure 7. Thin-section of X-2 soil sample. 40x magnification, plane polarized light illumination

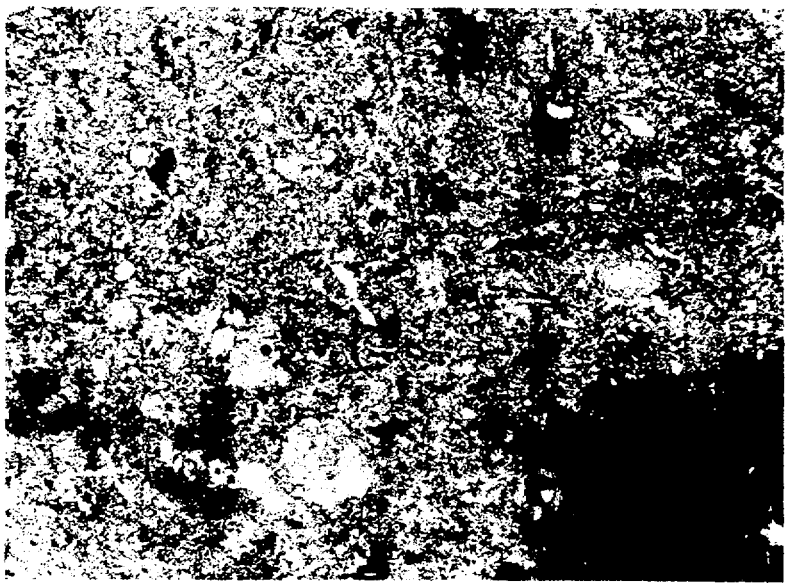


Figure 8. Same as Figure 7 except cross polarized light illumination.

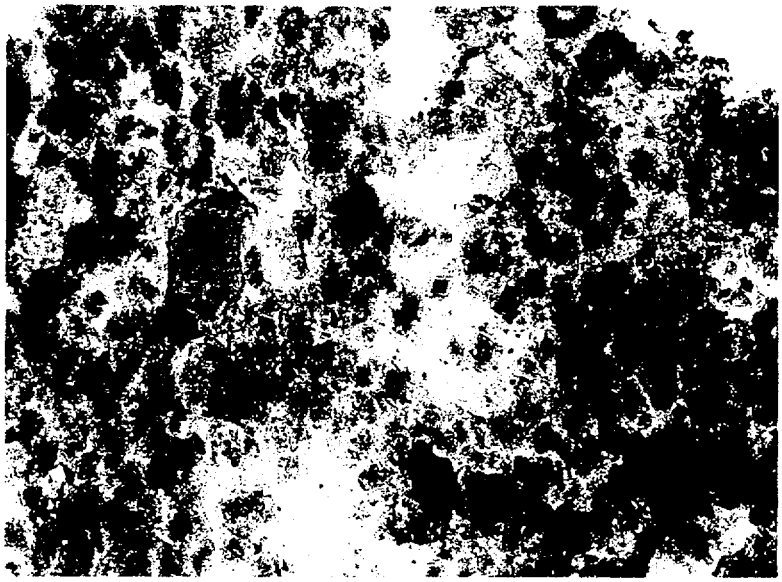


Figure 9. Thin-section of X-3 soil sample. 100x magnification, plane polarized light illumination

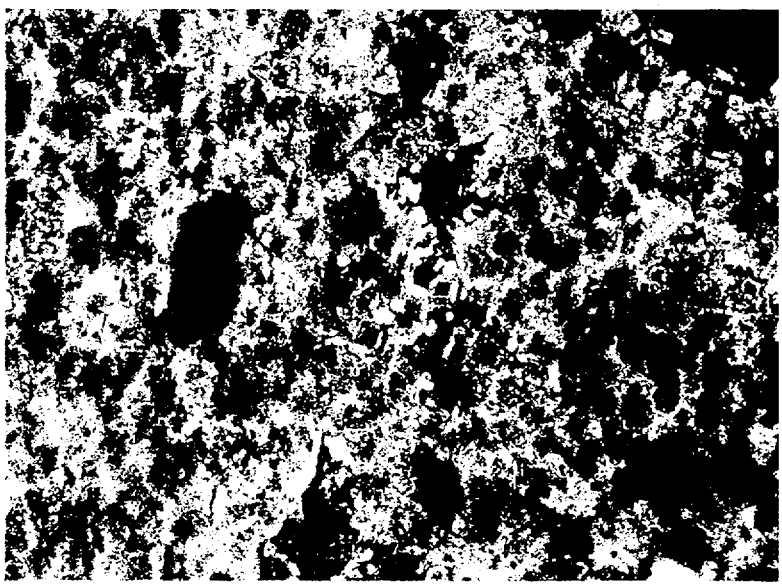


Figure 10. Same as Figure 9 except cross polarized light illumination.

Figure 11. Thin-section of X-3 soil sample. 40x magnification, plane polarized light illumination

Figure 12. Same as Figure 11 except cross polarized light illumination.

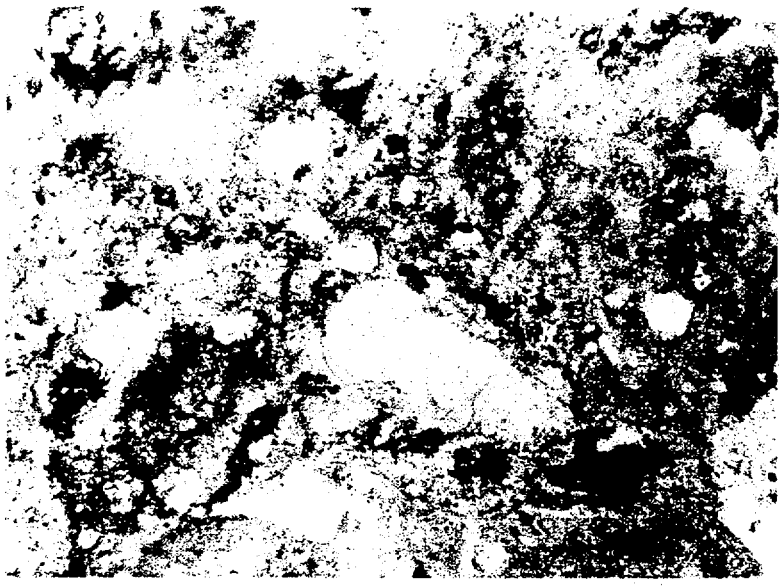


Figure 13. Thin-section of X-4 soil sample. 100x magnification, plane polarized light illumination

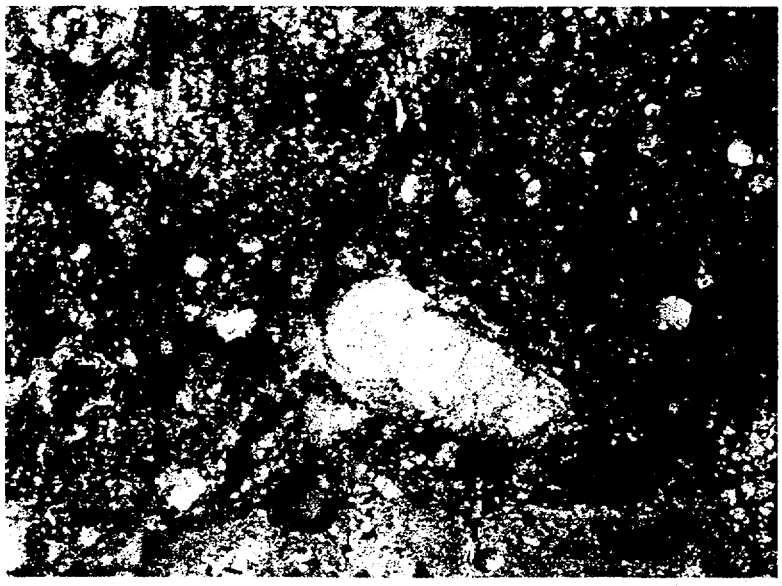


Figure 14. Same as Figure 13 except cross polarized light illumination.

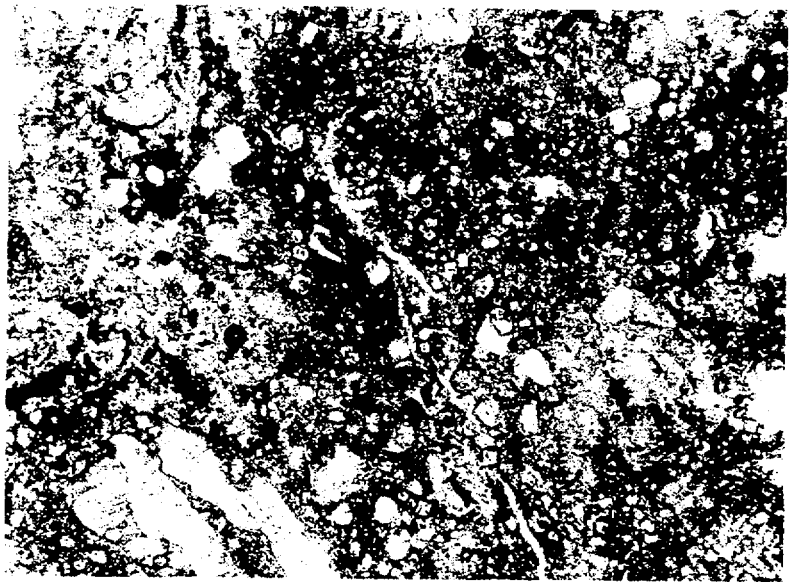


Figure 15. Thin-section of X-4 soil sample. 40x magnification, plane polarized light illumination

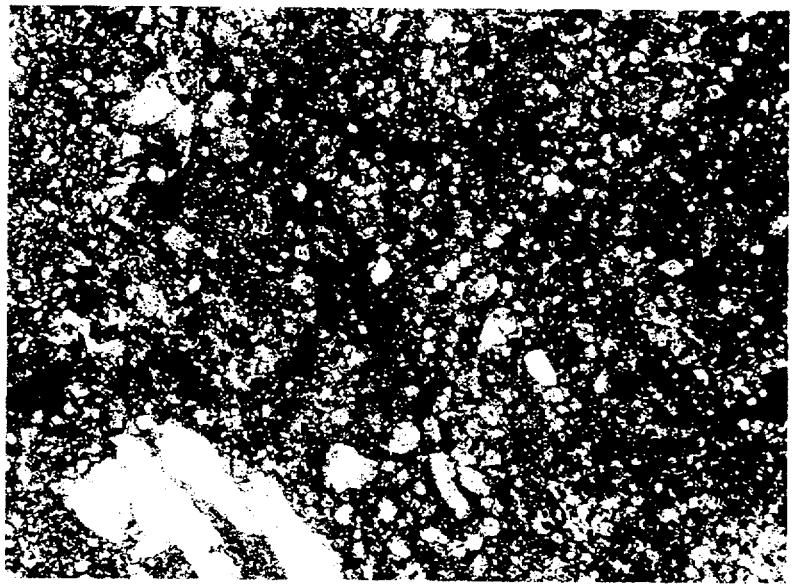
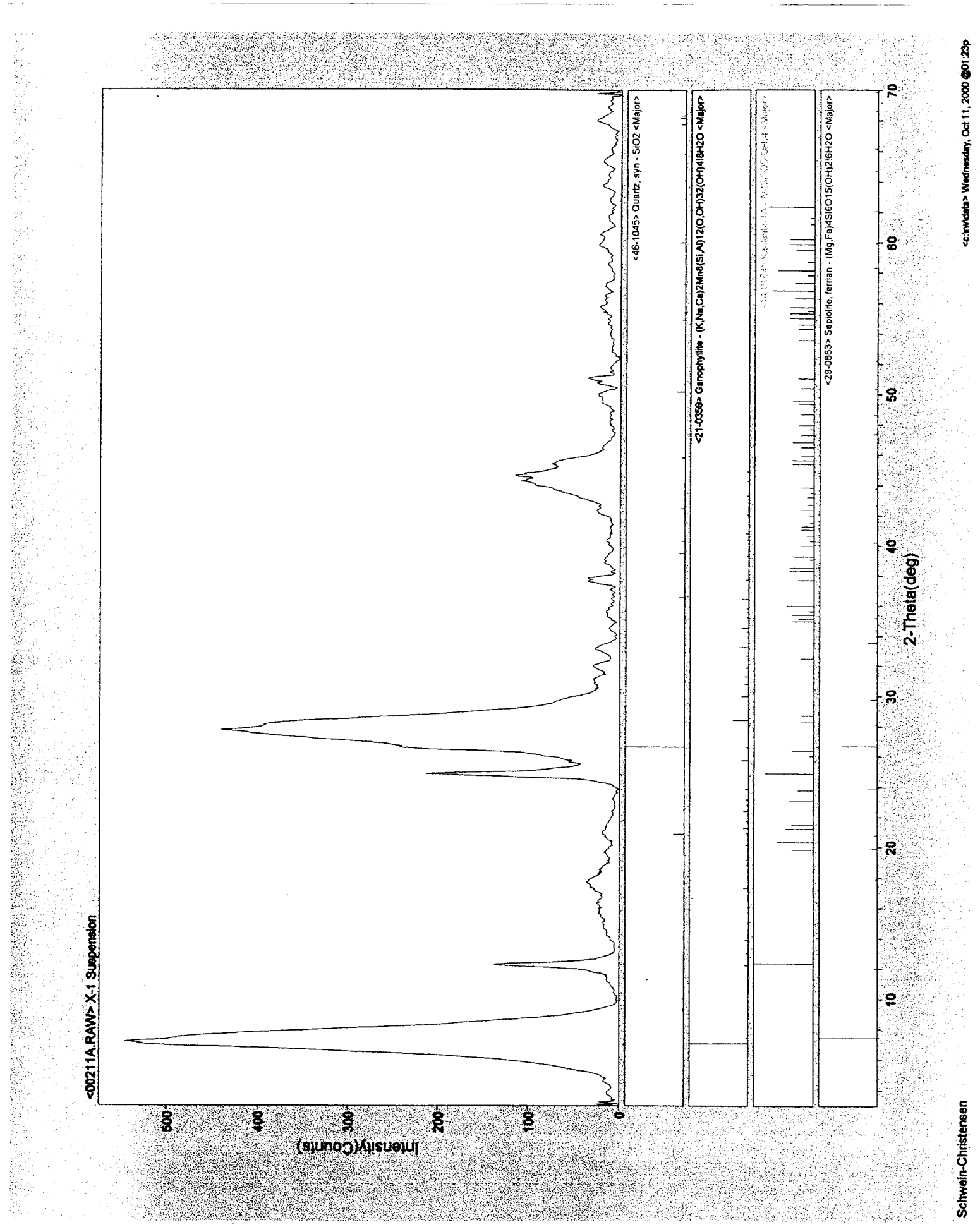
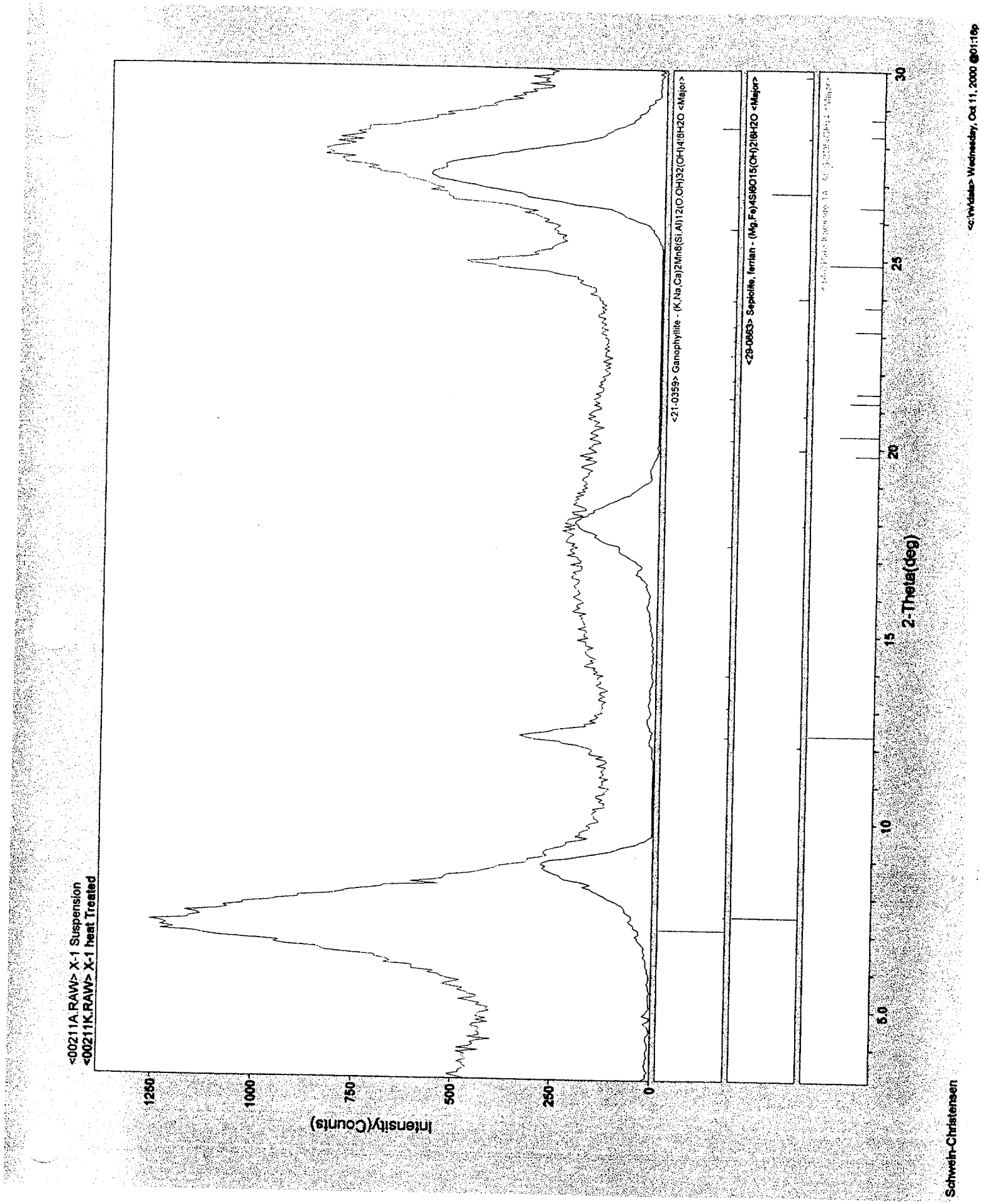


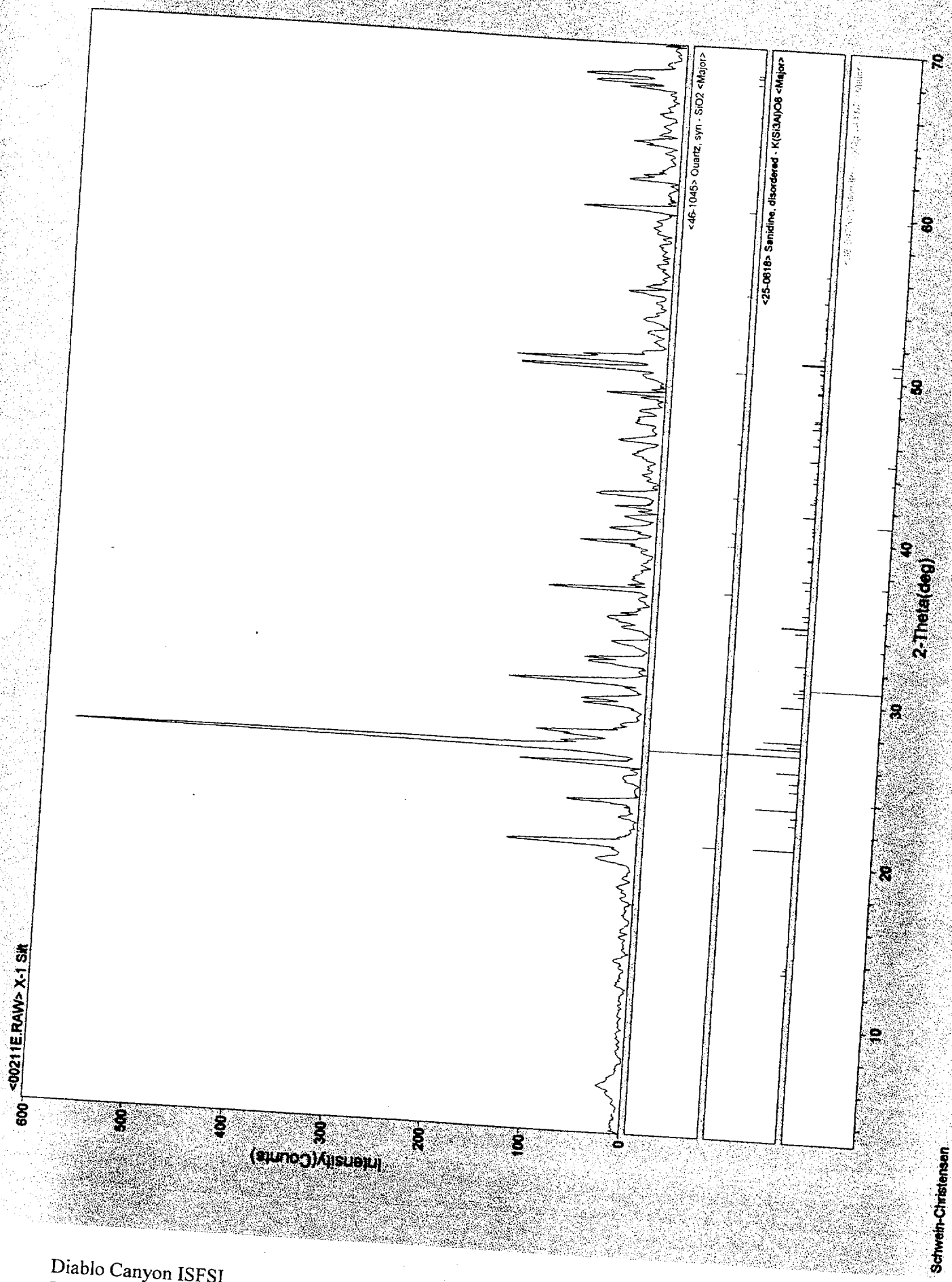
Figure 16. Same as Figure 15 except cross polarized light illumination.

X-1

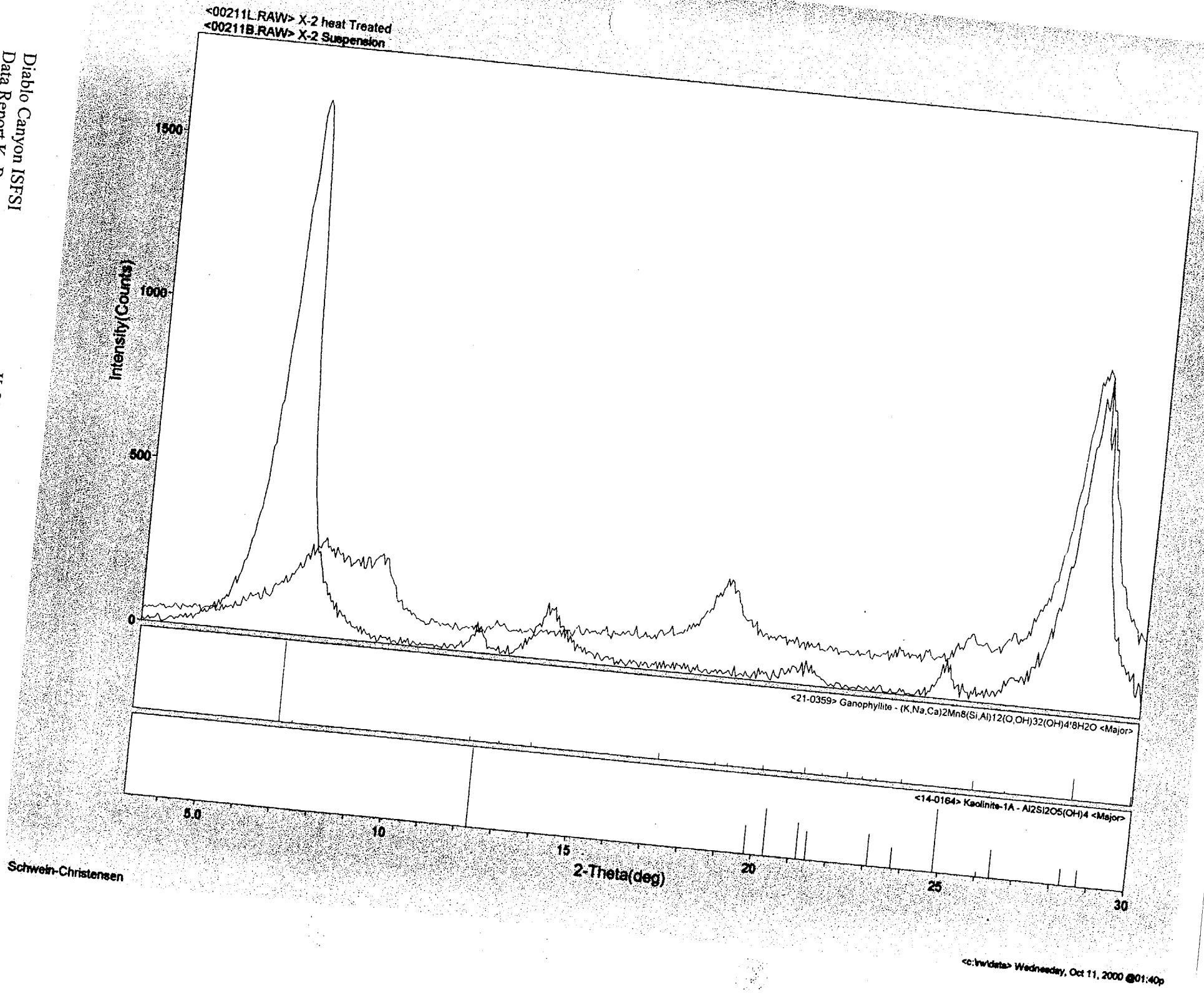

<00211A.RAW> X-1 Suspension
Intensity(Counts)
500
400
300
200
100
0
<46-1045> Quartz, syn - SiO2 <Major>
<21-0359> Ganophyllite - (K,Na,Ca)2Mn8(Si,Al)12(O,OH)32(OH)4[8]H2O <Major>
<29-0863> Sepiolite, ferrian - (Mg,Fe)4Si6O15(OH)2[6]H2O <Major>
10
20
30
40
50
60
70
2-Theta(deg)
<c:\rw\data> Wednesday, Oct 11, 2000 @01:23p
Schwein-Christensen


<00211A.RAW> X-1 Suspension
<00211K.RAW> X-1 heat Treated
Intensity(Counts)
1250
1000
750
500
250
0
5.0
10
15
20
25
30
2-Theta(deg)
<21-0359> Ganophyllite - (K,Na,Ca)2Mn8(Si,Al)12(O,OH)32(OH)4!8H2O <Major>
<29-0863> Sepiolite, ferrian - (Mg,Fe)4Si6O15(OH)2!6H2O <Major>
<c:\rw\data> Wednesday, Oct 11, 2000 @01:18p
Schwein-Christensen

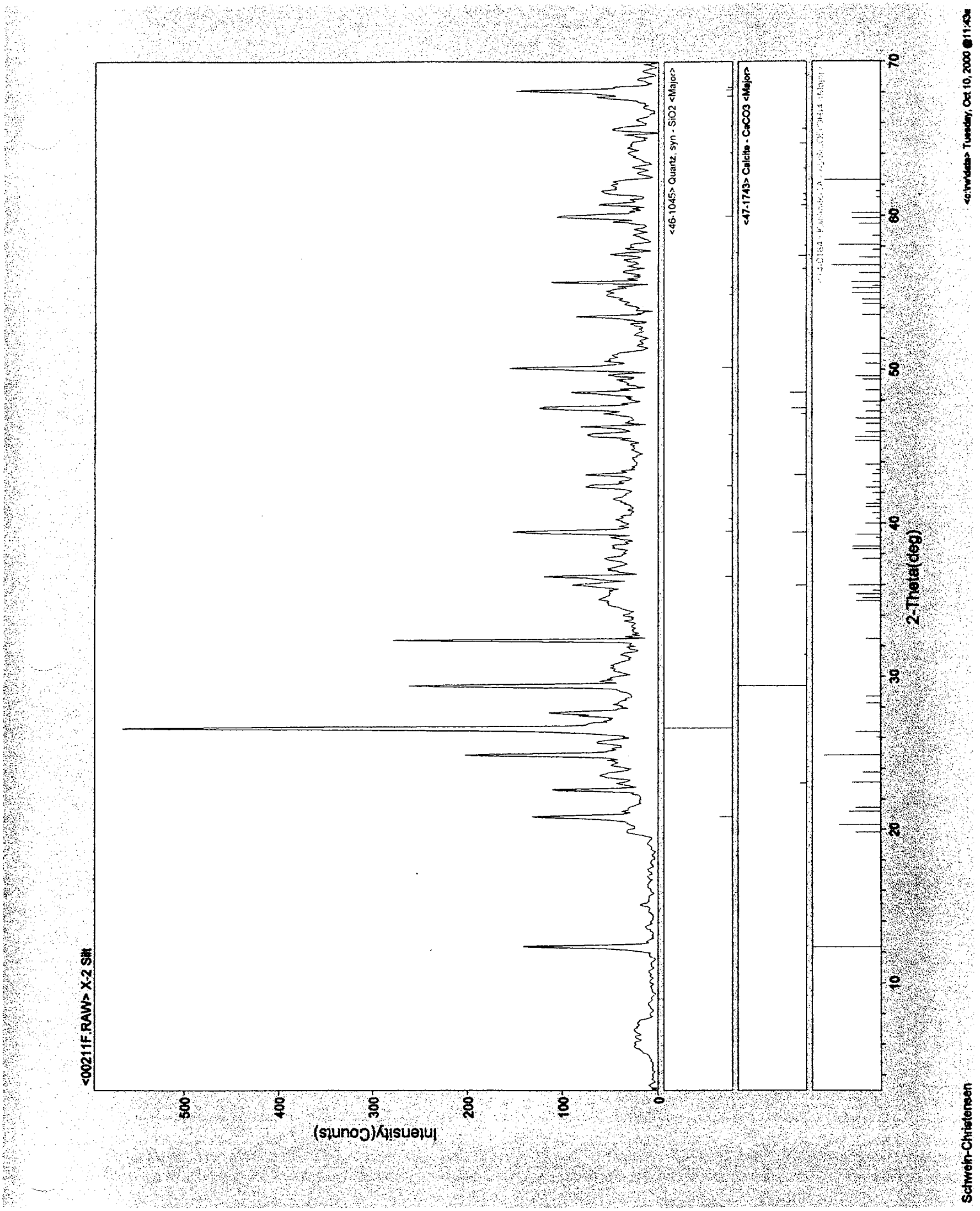
X-2

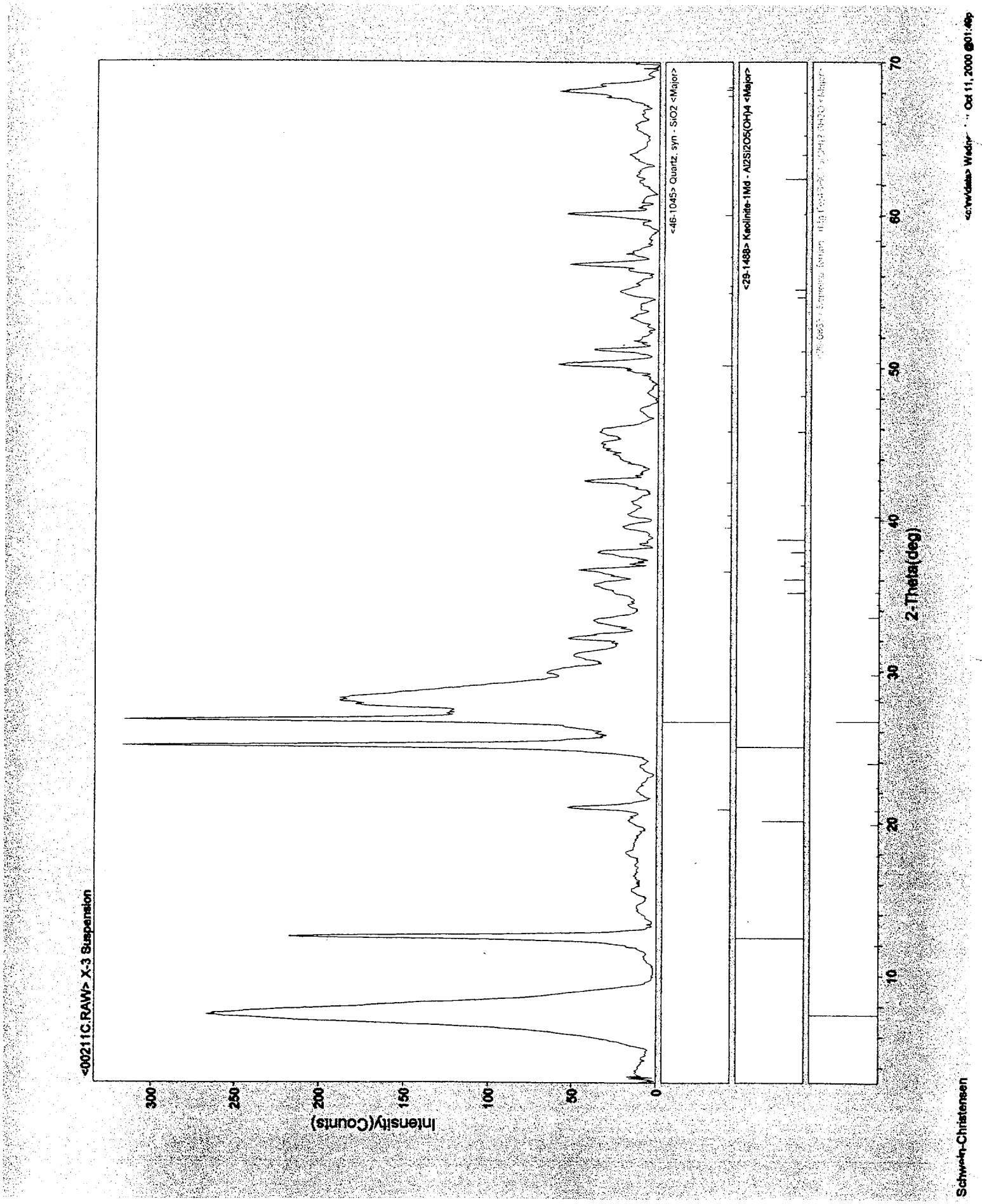

<00211E.RAW> X-1 Slit
Intensity(Counts)
600
500
400
300
200
100
0
<46-1045> Quartz, syn - SiO2 <Major>
<25-0618> Sanidine, disordered - K(Si3Al)O8 <Major>
2-Theta(deg)
10
20
30
40
50
60
70
Schwein-Christensen
<c:\rwdata> Wednesday, Oct 11, 2000 @01:32p

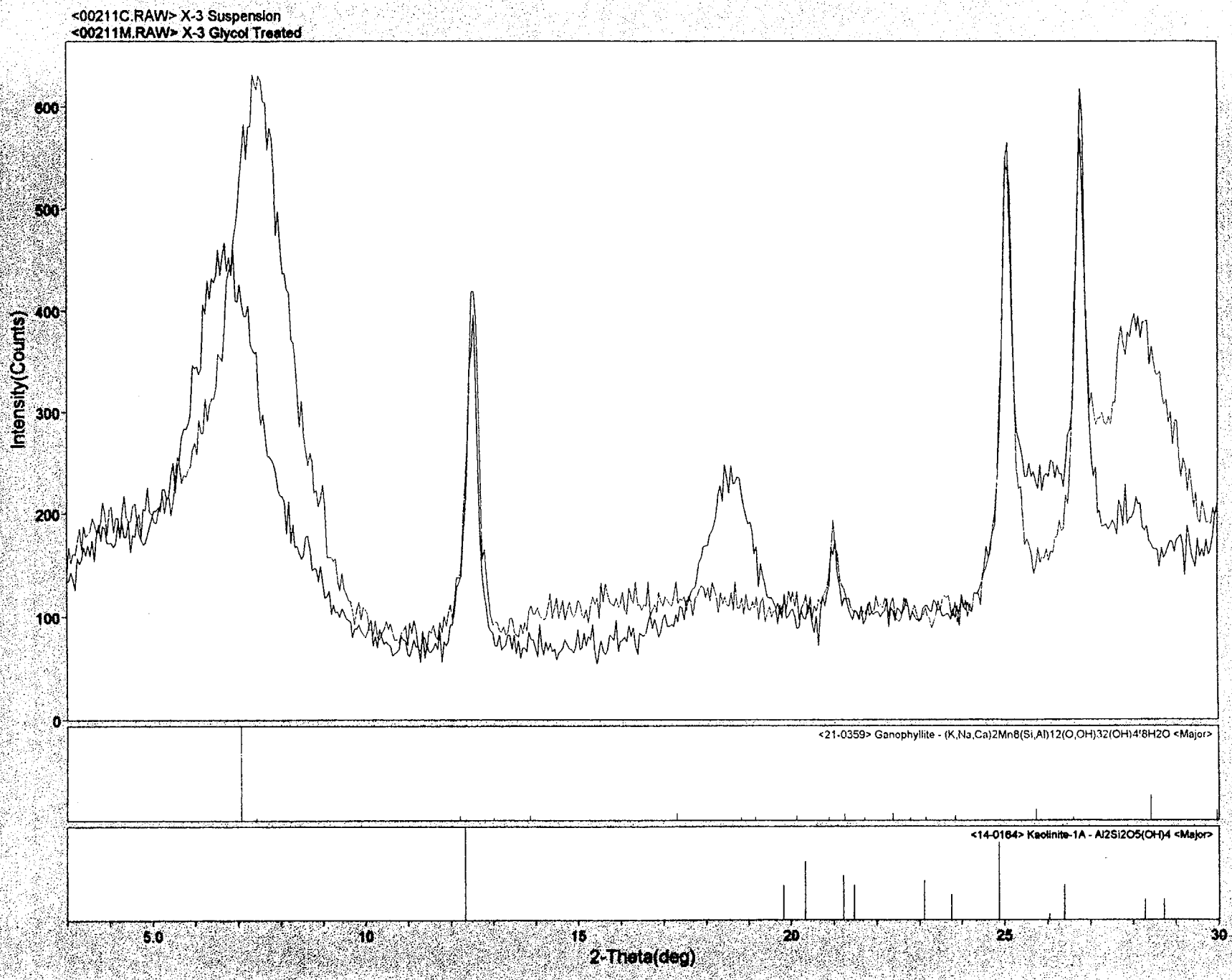
<00211B.RAW> X-2 Suspension
Intensity(Counts)
1500
1000
500
0
<21-0359> Ganophyllite - (K,Na,Ca)2Mn8(Si,Al)12(O,OH)32(OH)4·8H2O <Major>
<14-0164> Kaolinite-1A - Al2Si2O5(OH)4 <Minor>
2-Theta(deg)
10
20
30
40
50
60
70
Oct 10, 2000 @11:10a
Christensen


<00211L.RAW> X-2 heat Treated
<00211B.RAW> X-2 Suspension
Intensity(Counts)
1500
1000
500
0
<21-0359> Ganophyllite - (K,Na,Ca)2Mn8(Si,Al)12(O,OH)32(OH)4'8H2O <Major>
<14-0164> Kaolinite-1A - Al2Si2O5(OH)4 <Major>
5.0
10
15
20
25
30
2-Theta(deg)
Schwein-Christensen
<c:\rwidata> Wednesday, Oct 11, 2000 @01:40p

X-3


<00211F.RAW> X-2 Sit
Intensity(Counts)
500
400
300
200
100
0
<46-1045> Quartz, syn - SiO2 <Major>
<47-1743> Calcite - CaCO3 <Major>
2-Theta(deg)
10
20
30
40
50
60
70
Schwein-Christensen

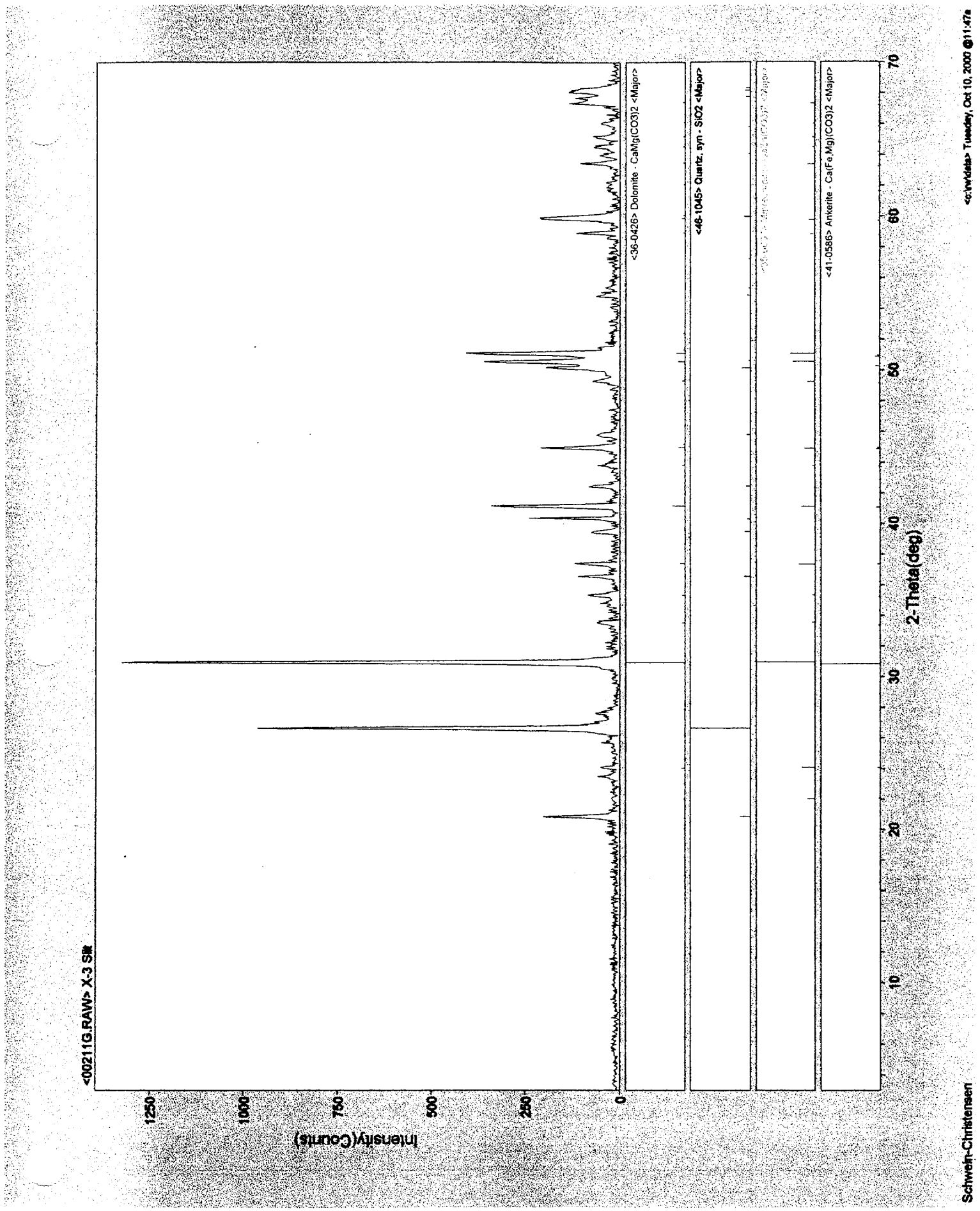

<00211C.RAW> X-3 Suspension
Intensity(Counts)
300
250
200
150
100
50
0
<46-1045> Quartz, syn - SiO2 <Major>
<29-1488> Kaolinite-1Md - Al2Si2O5(OH)4 <Major>
2-Theta(deg)
10
20
30
40
50
60
70
Schwein-Christensen

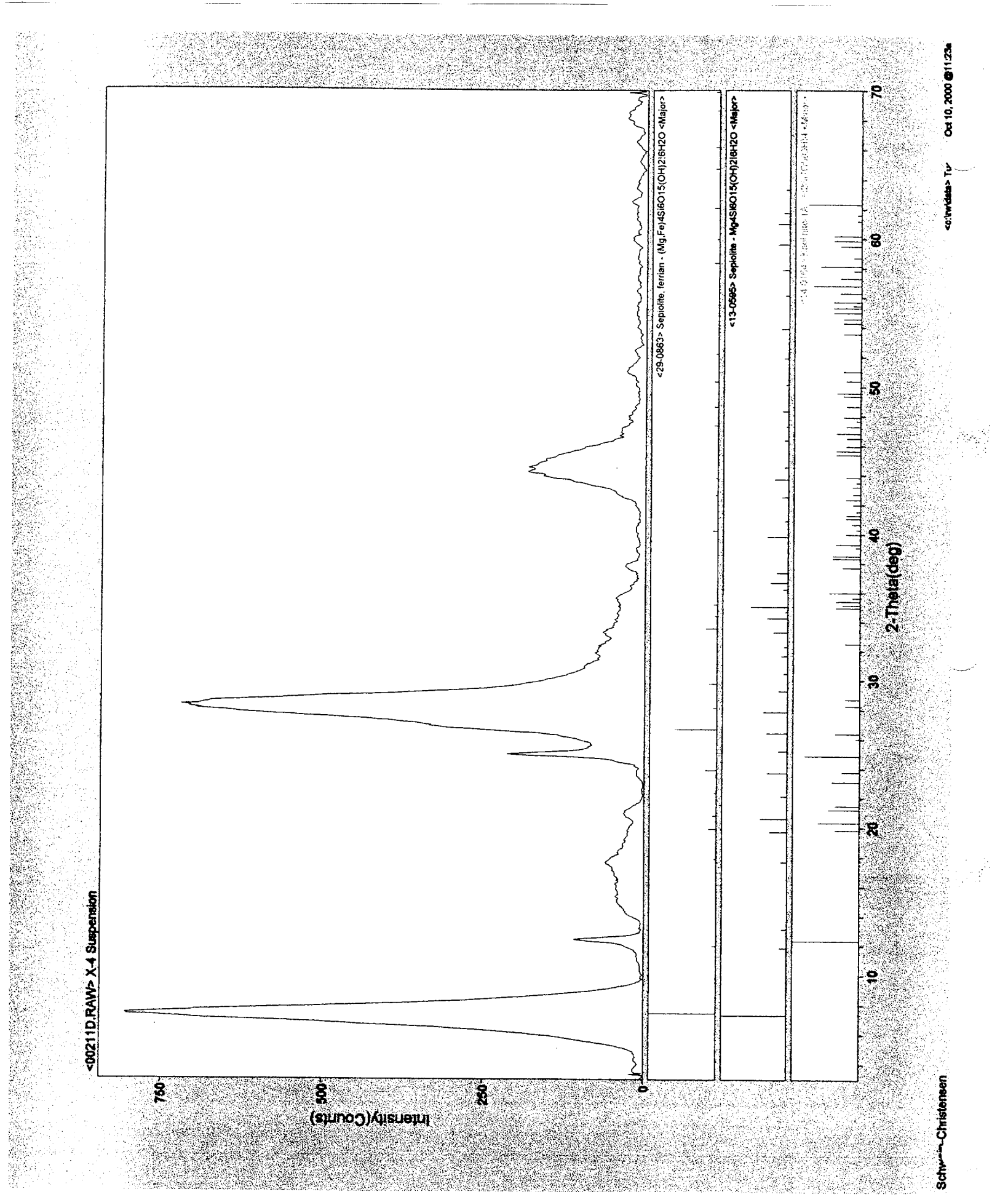


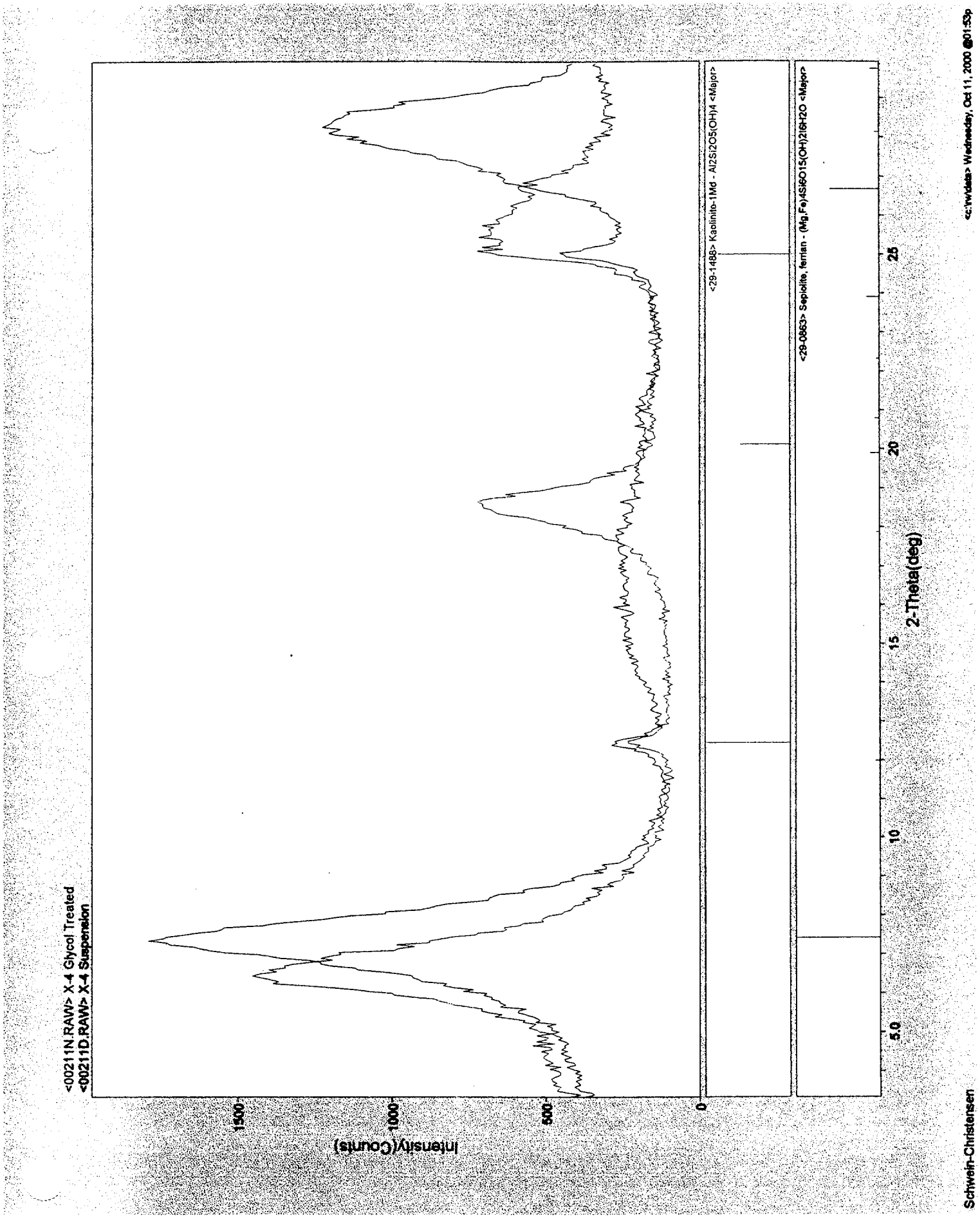
Schwein-Christensen

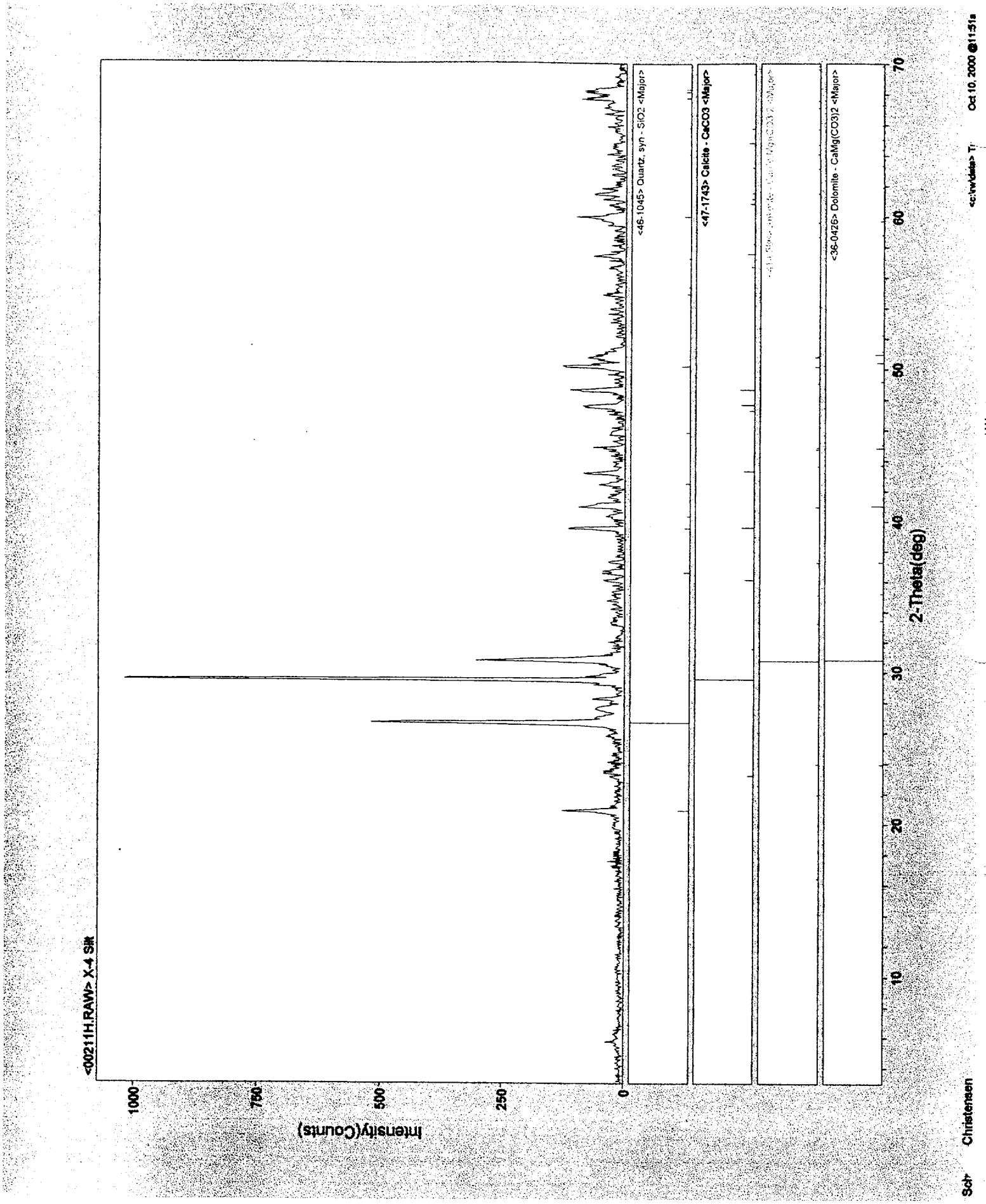
<c:\rw\data> Wednesday, Oct 11, 2000 @01:44p

X-4


<00211G.RAW> X-3 Silt
Intensity(Counts)
1250
1000
750
500
250
0
2-Theta(deg)
10
20
30
40
50
60
70
<36-0426> Dolomite - CaMg(CO3)2 <Major>
<46-1045> Quartz, syn - SiO2 <Major>
<41-0586> Ankerite - Ca(Fe,Mg)(CO3)2 <Major>
<c:\wxdata> Tuesday, Oct 10, 2000 @11:47a
Schwab-Christensen


<00211D.RAW> X-4 Suspension
Intensity(Counts)
750
500
250
0
<29-0863> Sepiolite, ferrian - (Mg,Fe)4Si6O15(OH)2.6H2O <Major>
<13-0585> Sepiolite - Mg4Si6O15(OH)2.6H2O <Major>
2-Theta(deg)
10
20
30
40
50
60
70
Oct 10, 2000 @11:23a
Schwarz-Christensen


<00211N.RAW> X-4 Glycol Treated
<00211D.RAW> X-4 Suspension
Intensity(Counts)
1500
1000
500
0
<29-1488> Kaolinite-1Md - Al2Si2O5(OH)4 <Major>
<29-0863> Sepiolite, ferrian - (Mg,Fe)4Si6O15(OH)2|6H2O <Major>
5.0
10
15
20
25
2-Theta(deg)
Schwein-Christensen
<c:\rwdata> Wednesday, Oct 11, 2000 @01:53p


<00211H.RAW> X-4 Silt
Intensity(Counts)
1000
750
500
250
0
2-Theta(deg)
10
20
30
40
50
60
70
<46-1045> Quartz, syn - SiO2 <Major>
<47-1743> Calcite - CaCO3 <Major>
<36-0426> Dolomite - CaMg(CO3)2 <Major>
Christensen
Oct 10, 2000 @11:51a