

PONTIFICIA UNIVERSIDAD CATÓLICA DEL PERU

Facultad de Ciencias e Ingeniería



**INFLUENCIA DE LA OPTIMIZACIÓN DE LA FRAGMENTACIÓN DE
ROCA EN LA RENTABILIDAD DE LAS OPERACIONES MINA-
MOLIENDA**

Tesis para optar el Título de Ingeniero de Minas

ANEXOS

Presentado por:

ALBERTO LEIVA TORRES

Lima-PERÚ

2007

ANEXO 1: UBICACIÓN CANTERA SHINCAMACHAY

Figura 1.1 La cantera de Shincamachay esta ubicada en la localidad de Shica distrito de Paccha a 4.5 Km. de la ciudad de la Oroya.

El acceso a la Cantera es a través de una carretera afirmada de 1 km. de longitud desde el km. 178 de la carretera central (tramo Oroya – Tarma).

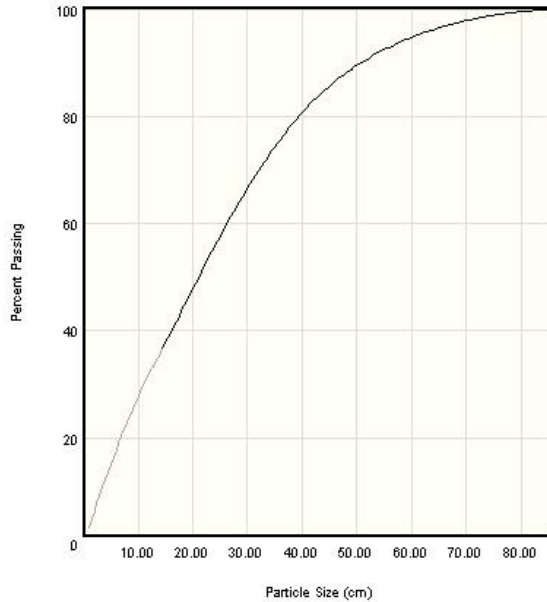


Figura 1.2 La Oroya se encuentra ubicada a 3750 msnm en la cuenca alta del río Mantaro, provincia de Yauli, Departamento de Junín, Sierra Central al oeste de la cordillera occidental del Perú. Distante 176 Km. al este de Lima.

ANEXO 2: RESULTADOS DEL ANÁLISIS DIGITAL

VOL310505 5 imágenes

CUMULATIVE SIZE DISTRIBUTION



size (mm)	%
1905.00	100.00
1270.00	100.00
635.00	96.02
381.00	78.40
254.00	58.40
203.20	48.35
152.40	38.22
101.60	27.91
50.80	15.32
38.10	11.76
25.40	8.02
19.05	6.08
12.70	4.09
9.525	3.09
6.350	2.06
4.750	1.55
1.999	0.65

P20 Size (mm) 68.50
P50 Size (mm) 211.30
P80 Size (mm) 394.19
Top size (mm) 796.44



Cumulative Percent Passing
Data

Sieve series: US

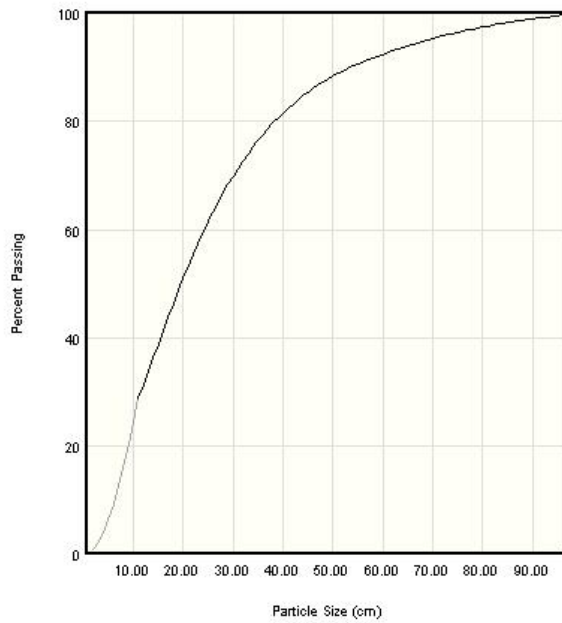
5 Images

Date: Wed Oct 05 02:30:29 2005

Size [mm]	All Images	BI-1B	BI-2B	BI-3B	BI-1A	BI-2A
1905.00	100.00	100.00	100.00	100.00	100.00	100.00
1270.00	100.00	100.00	100.00	100.00	100.00	100.00
635.00	96.02	97.70	97.06	96.43	95.73	94.75
381.00	78.40	83.82	76.90	83.47	74.08	78.49
254.00	58.40	64.28	54.24	63.63	53.62	60.42
203.20	48.35	55.63	44.32	52.85	43.74	50.39
152.40	38.22	46.01	34.68	42.20	34.11	39.69
101.60	27.91	33.63	23.01	29.40	23.03	26.92
50.80	15.32	18.46	10.75	14.73	11.15	12.72
38.10	11.76	14.17	7.74	10.89	8.15	9.18
25.40	8.02	9.66	4.84	7.04	5.20	5.74
19.05	6.08	7.33	3.45	5.14	3.77	4.10
12.70	4.09	4.93	2.14	3.29	2.38	2.54
9.525	3.09	3.72	1.51	2.38	1.71	1.79
6.350	2.06	2.48	0.92	1.50	1.07	1.09
4.750	1.55	1.86	0.64	1.07	0.76	0.75
1.999	0.65	0.78	0.27	0.45	0.32	0.32

Fines factor: 20.00
RosRam uniformity: 1.15
RosRam X50: 19.07
R-squared: 0.9911
Schuhmann Slope: 0.77
Schuhmann X50: 22.34
R-squared: 0.9909

VOL300505 5 imágenes
CUMULATIVE SIZE DISTRIBUTION



size (mm)	%
1905.00	100.00
1270.00	100.00
635.00	93.56
381.00	79.81
254.00	62.19
203.20	51.76
152.40	39.56
101.60	25.21
50.80	6.68
38.10	3.74
25.40	1.65
19.05	0.87
12.70	0.37
9.525	0.15
6.350	0.10
4.750	0.07
1.999	0.03

P20 Size (mm)	89.24
P50 Size (mm)	195.49
P80 Size (mm)	382.99
Top size (mm)	945.51



Cumulative Percent Passing
Data

Sieve series: US

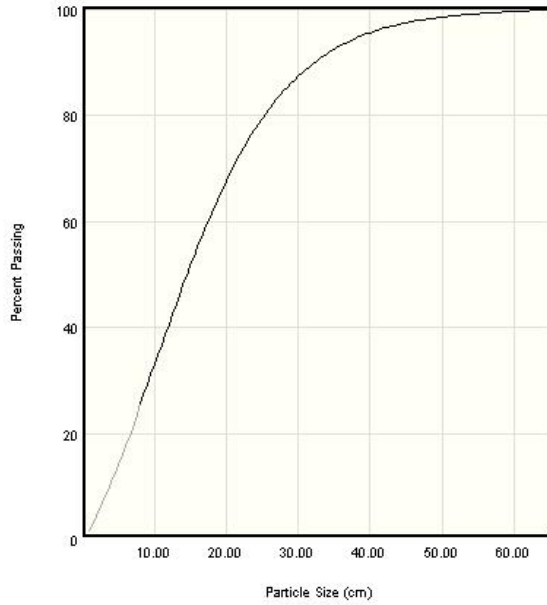
6 Images

Date: Tue Oct 04 21:24:14 2005

Size [mm]	All Images	BI-4B	BI-1B	BI-2B	BI-3B	BI-2A	BI-1A
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1270.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
635.00	93.56	100.00	100.00	97.60	100.00	95.63	89.39
381.00	79.81	90.67	94.82	78.14	91.87	86.24	68.64
254.00	62.19	70.63	77.46	55.30	70.23	69.41	51.26
203.20	51.76	58.86	65.23	44.94	57.91	57.59	42.68
152.40	39.56	45.56	50.48	33.11	44.15	43.12	33.15
101.60	25.21	24.92	32.85	20.14	25.42	27.52	23.24
50.80	6.68	7.67	8.71	8.02	7.10	10.17	11.95
38.10	3.74	4.62	4.88	5.40	4.11	6.60	8.97
25.40	1.65	2.26	2.16	3.07	1.90	3.55	5.93
19.05	0.87	1.30	1.14	2.02	1.05	2.22	4.41
12.70	0.37	0.60	0.48	1.11	0.46	1.15	2.89
9.525	0.15	0.29	0.20	0.69	0.20	0.66	2.13
6.350	0.10	0.20	0.13	0.46	0.14	0.44	1.42
4.750	0.07	0.15	0.10	0.34	0.10	0.33	1.06
1.999	0.03	0.06	0.04	0.14	0.04	0.14	0.45

Fines factor: 20.00
 RosRam uniformity: 1.32
 RosRam X50: 20.85
 R-squared: 0.9868
 Schuhmann Slope: 0.84
 Schuhmann X50: 24.15
 R-squared: 0.9075

VOL200505 9 imágenes
 CUMULATIVE SIZE DISTRIBUTION



size (mm)	%
1905.00	100.00
1270.00	100.00
635.00	99.81
381.00	94.58
254.00	80.24
203.20	68.53
152.40	52.50
101.60	33.72
50.80	14.63
38.10	10.41
25.40	6.35
19.05	4.44
12.70	2.67
9.525	1.83
6.350	1.08
4.750	0.72
1.999	0.30

P20 Size (mm)	66.76
P50 Size (mm)	145.37
P80 Size (mm)	252.76
Top size (mm)	589.10

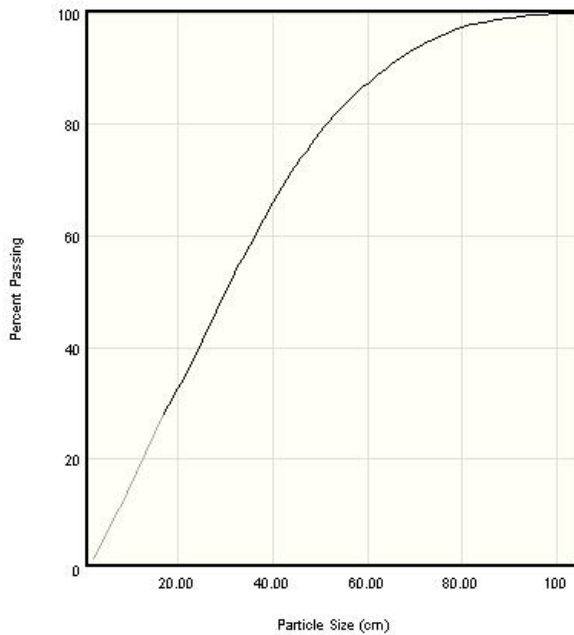


Cumulative Percent Passing Data Sieve series: US 9 Images Date: Tue Oct 04 22:51:42 2005

Size [mm]	All Images	BI-A7	BI-A1	BI-A2	BI-A3	BI-A4	BI-A5	BI-A6	BI-B2	BI-B1
1905.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1270.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
635.00	99.81	100.00	100.00	100.00	100.00	100.00	99.06	100.00	100.00	99.59
381.00	94.58	99.87	97.62	95.97	91.12	98.82	81.87	97.28	99.46	91.67
254.00	80.24	91.77	89.89	79.63	74.14	86.43	61.75	81.08	89.57	70.72
203.20	68.53	80.42	82.53	66.57	62.98	74.26	50.18	67.99	77.51	55.04
152.40	52.50	62.70	67.21	50.13	48.61	57.15	37.03	51.42	57.88	37.24
101.60	33.72	41.82	42.91	31.41	32.65	37.64	23.89	33.60	34.32	17.97
50.80	14.63	18.99	13.10	8.95	15.25	17.68	10.32	14.38	8.30	3.77
38.10	10.41	13.27	7.12	5.16	10.90	12.58	7.18	9.74	4.42	1.95
25.40	6.35	7.88	2.96	2.35	6.71	7.67	4.27	5.54	1.80	0.77
19.05	4.44	5.40	1.60	1.35	4.73	5.37	2.95	3.70	0.96	0.40
12.70	2.67	3.15	0.68	0.63	2.88	3.22	1.74	2.08	0.41	0.17
9.525	1.83	2.12	0.35	0.35	2.00	2.22	1.18	1.36	0.21	0.08
6.350	1.08	1.20	0.14	0.15	1.19	1.30	0.68	0.74	0.08	0.03
4.750	0.72	0.77	0.05	0.07	0.80	0.87	0.44	0.46	0.03	0.01
1.999	0.30	0.32	0.02	0.03	0.34	0.36	0.19	0.19	0.01	0.00

Fines factor: 20.00
 RosRam uniformity: 1.44
 RosRam X50: 14.21
 R-squared: 0.9990
 Schuhmann Slope: 0.98
 Schuhmann X50: 16.35
 R-squared: 0.9769

VOL180605 5 imágenes
CUMULATIVE SIZE DISTRIBUTION



size (mm)	%
1905.00	100.00
1270.00	100.00
635.00	89.74
381.00	63.11
254.00	41.94
203.20	33.37
152.40	25.16
101.60	16.09
50.80	7.10
38.10	5.01
25.40	3.03
19.05	2.10
12.70	1.24
9.525	0.84
6.350	0.56
4.750	0.42
1.999	0.18

P20 Size (mm)	123.31
P50 Size (mm)	300.71
P80 Size (mm)	513.25
Top size (mm)	940.64

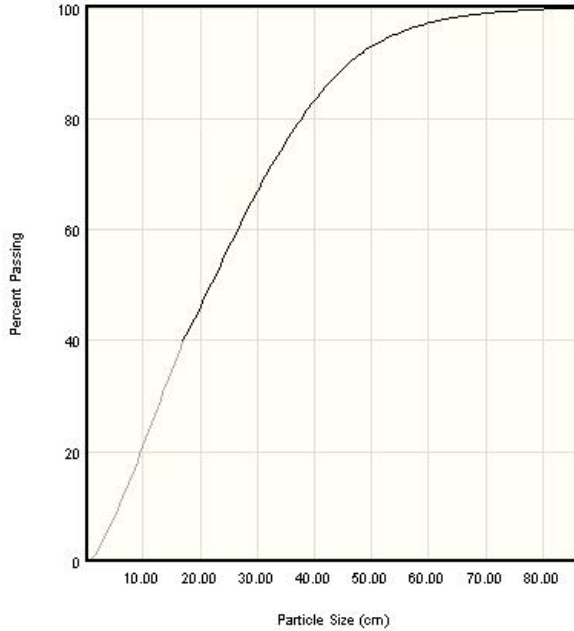


Cumulative Percent Passing Sieve series: US 6 Images Date: Wed Oct 05 21:13:57 2005

Size [mm]	All Images	BI-B6	BI-B1	BI-B2	BI-B3	BI-B4	BI-B5
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1270.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
635.00	89.74	82.93	93.72	92.34	93.88	93.38	88.30
381.00	63.11	56.40	66.85	65.31	67.94	69.55	57.81
254.00	41.94	35.38	43.53	41.50	48.14	48.82	35.12
203.20	33.37	27.04	33.97	31.60	39.66	39.18	26.40
152.40	25.16	18.34	23.44	21.84	30.36	29.55	17.73
101.60	16.09	10.32	13.32	12.53	20.19	18.90	9.83
50.80	7.10	3.72	4.82	4.64	9.58	8.34	3.47
38.10	5.01	2.43	3.14	3.05	6.95	5.88	2.24
25.40	3.03	1.33	1.71	1.68	4.39	3.56	1.21
19.05	2.10	0.84	1.08	1.08	3.14	2.47	0.76
12.70	1.24	0.45	0.57	0.58	1.95	1.46	0.40
9.525	0.84	0.26	0.33	0.35	1.38	0.98	0.23
6.350	0.56	0.18	0.22	0.23	0.92	0.66	0.15
4.750	0.42	0.13	0.17	0.17	0.69	0.49	0.11
1.999	0.18	0.06	0.07	0.07	0.29	0.21	0.05

Fines factor: 20.00
 RosRam uniformity: 1.39
 RosRam X50: 28.17
 R-squared: 0.9949
 Schuhmann Slope: 0.97
 Schuhmann X50: 32.26
 R-squared: 0.9891

VOL080605 4 imágenes
 CUMULATIVE SIZE DISTRIBUTION



size (mm)	%
1905.00	100.00
1270.00	100.00
635.00	98.06
381.00	80.69
254.00	57.48
203.20	46.67
152.40	35.31
101.60	21.39
50.80	8.37
38.10	5.60
25.40	3.15
19.05	2.09
12.70	1.17
9.525	0.76
6.350	0.41
4.750	0.25
1.999	0.11

P20 Size (mm)	96.50
P50 Size (mm)	218.90
P80 Size (mm)	376.32
Top size (mm)	761.03



Cumulative Percent Passing
 Data

Sieve series: US

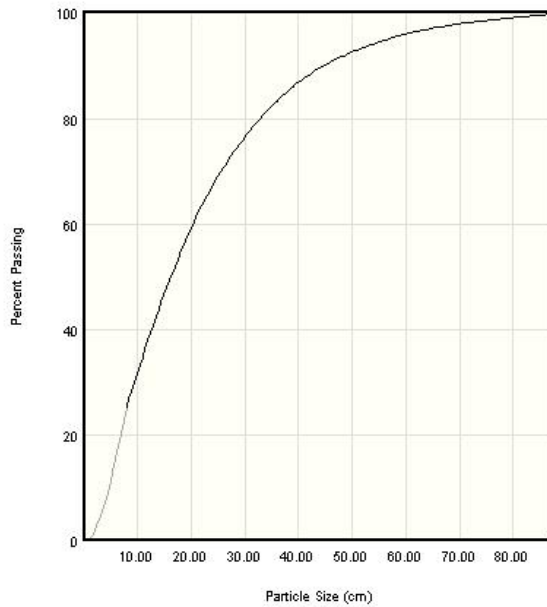
4 Images

Date: Sat Oct 01 23:11:49 2005

Size [mm]	All Images	BI-3A	BI-VOL1A	BI-2A	BI-4B
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1270.00	100.00	100.00	100.00	100.00	100.00
635.00	98.06	96.96	98.35	99.78	98.04
381.00	80.69	75.32	81.79	86.54	81.69
254.00	57.48	51.60	58.98	60.93	58.99
203.20	46.67	41.89	47.67	49.49	48.20
152.40	35.31	30.45	36.49	36.19	37.39
101.60	21.39	18.64	23.83	21.92	24.42
50.80	8.37	7.57	10.76	8.58	11.00
38.10	5.60	5.16	7.63	5.73	7.79
25.40	3.15	2.98	4.66	3.22	4.75
19.05	2.09	2.02	3.28	2.14	3.33
12.70	1.17	1.16	1.98	1.20	2.01
9.525	0.76	0.77	1.37	0.78	1.39
6.350	0.41	0.43	0.82	0.42	0.82
4.750	0.25	0.27	0.55	0.26	0.55
1.999	0.11	0.11	0.23	0.11	0.23

Fines factor: 20.00
 RosRam uniformity: 1.48
 RosRam X50: 21.09
 R-squared: 0.9980
 Schuhmann Slope: 1.01
 Schuhmann X50: 23.93
 R-squared: 0.9793

VOL070605 5 imágenes
 CUMULATIVE SIZE DISTRIBUTION



size (mm)	%
1905.00	100.00
1270.00	100.00
635.00	96.80
381.00	85.25
254.00	69.60
203.20	59.82
152.40	47.27
101.60	32.14
50.80	11.37
38.10	6.52
25.40	2.89
19.05	1.63
12.70	0.73
9.525	0.39
6.350	0.17
4.750	0.07
1.999	0.03

P20 Size (mm)	69.34
P50 Size (mm)	162.78
P80 Size (mm)	328.98
Top size (mm)	841.22



Cumulative Percent Passing
 Data

Sieve series: US

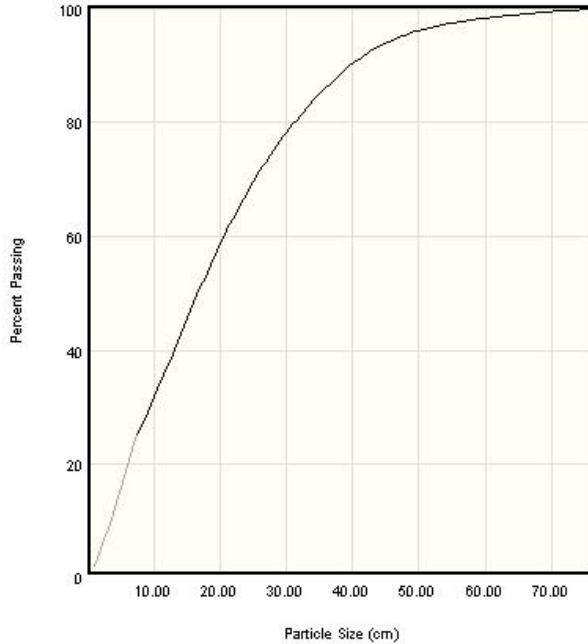
5 Images

Date: Fri Oct 07 03:15:50 2005

Size [mm]	All Images	BI-2B	BI-3B	BI-4B	BI-1A	BI-2A
1905.00	100.00	100.00	100.00	100.00	100.00	100.00
1270.00	100.00	100.00	100.00	100.00	100.00	100.00
635.00	96.80	100.00	100.00	97.25	99.12	95.53
381.00	85.25	100.00	94.38	84.95	86.40	83.06
254.00	69.60	97.07	80.00	65.36	68.77	65.86
203.20	59.82	91.07	69.91	53.45	57.95	54.50
152.40	47.27	76.89	54.50	40.83	44.47	41.58
101.60	32.14	52.88	36.52	27.28	30.80	28.70
50.80	11.37	18.67	17.66	12.34	14.81	13.90
38.10	6.52	10.71	12.69	8.73	10.74	10.12
25.40	2.89	4.75	7.87	5.31	6.75	6.42
19.05	1.63	2.67	5.57	3.72	4.84	4.62
12.70	0.73	1.19	3.40	2.24	3.00	2.89
9.525	0.39	0.64	2.37	1.54	2.12	2.06
6.350	0.17	0.27	1.41	0.91	1.30	1.27
4.750	0.07	0.11	0.96	0.61	0.90	0.89
1.999	0.03	0.05	0.40	0.26	0.38	0.37

Fines factor: 20.00
 RosRam uniformity: 1.29
 RosRam X50: 17.19
 R-squared: 0.9910
 Schuhmann Slope: 0.83
 Schuhmann X50: 19.97
 R-squared: 0.9198

VOL050505 imágenes
CUMULATIVE SIZE DISTRIBUTION



size (mm)	%
1905.00	100.00
1270.00	100.00
635.00	98.70
381.00	88.52
254.00	70.32
203.20	59.41
152.40	46.35
101.60	32.31
50.80	16.42
38.10	11.72
25.40	7.19
19.05	5.05
12.70	3.05
9.525	2.11
6.350	1.25
4.750	0.84
1.999	0.35

P20 Size (mm)	60.38
P50 Size (mm)	165.84
P80 Size (mm)	311.87
Top size (mm)	708.26

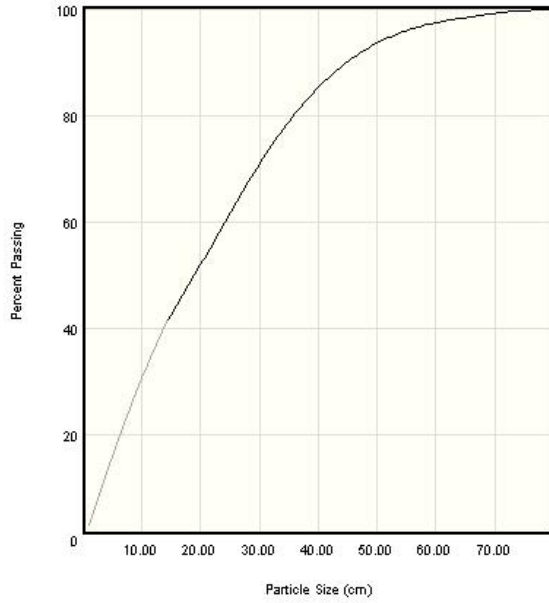


Cumulative Percent Passing Data Sieve series: US 8 Images Date: Fri Oct 07 11:32:31 2005

Size [mm]	All Images	BI-4B	BI-1B	BI-2B	BI-3B	BI-4A	BI-1A	BI-2A	BI-3A
1905.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1270.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
635.00	98.70	94.44	100.00	100.00	100.00	98.72	96.60	100.00	100.00
381.00	88.52	75.51	85.73	91.71	95.89	89.85	85.46	91.57	90.68
254.00	70.32	56.38	68.44	73.37	80.95	73.57	69.71	69.07	68.22
203.20	59.41	48.03	59.30	61.40	69.12	62.01	58.83	56.59	56.76
152.40	46.35	38.42	48.53	47.87	53.81	46.69	44.97	43.55	45.33
101.60	32.31	27.58	35.80	33.63	36.32	30.03	29.92	29.33	31.31
50.80	16.42	15.37	19.45	16.53	17.04	13.40	13.49	13.62	15.38
38.10	11.72	11.82	14.84	12.07	12.16	9.39	9.52	9.73	11.26
25.40	7.19	8.10	10.02	7.66	7.46	5.63	5.75	6.00	7.17
19.05	5.05	6.17	7.54	5.52	5.24	3.90	4.01	4.24	5.18
12.70	3.05	4.18	5.02	3.46	3.17	2.31	2.40	2.58	3.26
9.525	2.11	3.17	3.75	2.46	2.19	1.57	1.64	1.80	2.32
6.350	1.25	2.14	2.47	1.51	1.29	0.91	0.96	1.07	1.44
4.750	0.84	1.62	1.83	1.06	0.87	0.60	0.64	0.73	1.01
1.999	0.35	0.68	0.77	0.44	0.37	0.25	0.27	0.31	0.42

Fines factor: 20.00
 RosRam uniformity: 1.25
 RosRam X50: 15.73
 R-squared: 0.9971
 Schuhmann Slope: 0.85
 Schuhmann X50: 18.30
 R-squared: 0.9804

VOL010605 5 imágenes
 CUMULATIVE SIZE DISTRIBUTION



size (mm)	%
1905.00	100.00
1270.00	100.00
635.00	98.10
381.00	83.05
254.00	62.61
203.20	52.63
152.40	42.91
101.60	31.00
50.80	16.25
38.10	12.21
25.40	8.07
19.05	5.98
12.70	3.90
9.525	2.87
6.350	1.85
4.750	1.34
1.999	0.56

P20 Size (mm)	62.97
P50 Size (mm)	189.84
P80 Size (mm)	357.63
Top size (mm)	726.84



Cumulative Percent Passing
 Data

Sieve series: US

5 Images

Date: Fri Oct 07 02:45:10 2005

Size [mm]	All Images	BI-2A	BI-1A	BI-3B	BI-1B	BI-2B
1905.00	100.00	100.00	100.00	100.00	100.00	100.00
1270.00	100.00	100.00	100.00	100.00	100.00	100.00
635.00	98.10	97.46	98.13	97.96	100.00	99.02
381.00	83.05	80.89	85.88	79.06	91.69	84.69
254.00	62.61	59.09	65.75	59.99	70.29	63.82
203.20	52.63	48.79	55.59	51.19	58.89	53.89
152.40	42.91	38.20	45.11	41.08	47.67	44.17
101.60	31.00	25.40	32.01	28.93	34.38	32.13
50.80	16.25	11.81	16.61	14.93	18.02	17.25
38.10	12.21	8.47	12.44	11.19	13.54	13.12
25.40	8.07	5.26	8.20	7.38	8.95	8.84
19.05	5.98	3.73	6.06	5.47	6.64	6.64
12.70	3.90	2.29	3.94	3.56	4.33	4.42
9.525	2.87	1.61	2.89	2.62	3.18	3.30
6.350	1.85	0.97	1.86	1.69	2.05	2.17
4.750	1.34	0.66	1.35	1.23	1.49	1.61
1.999	0.56	0.28	0.57	0.52	0.63	0.68

Fines factor: 20.00
 RosRam uniformity: 1.17
 RosRam X50: 17.29
 R-squared: 0.9917
 Schuhmann Slope: 0.79
 Schuhmann X50: 20.08
 R-squared: 0.9894

ANEXO 3: RESULTADOS DEL ANÁLISIS DE FRAGMENTACIÓN DE LOS MODELOS

Figura 3.1 RESULTADOS DEL ANÁLISIS DE FRAGMENTACIÓN PARA 46mm DE DIAMETRO DE PERFORACION

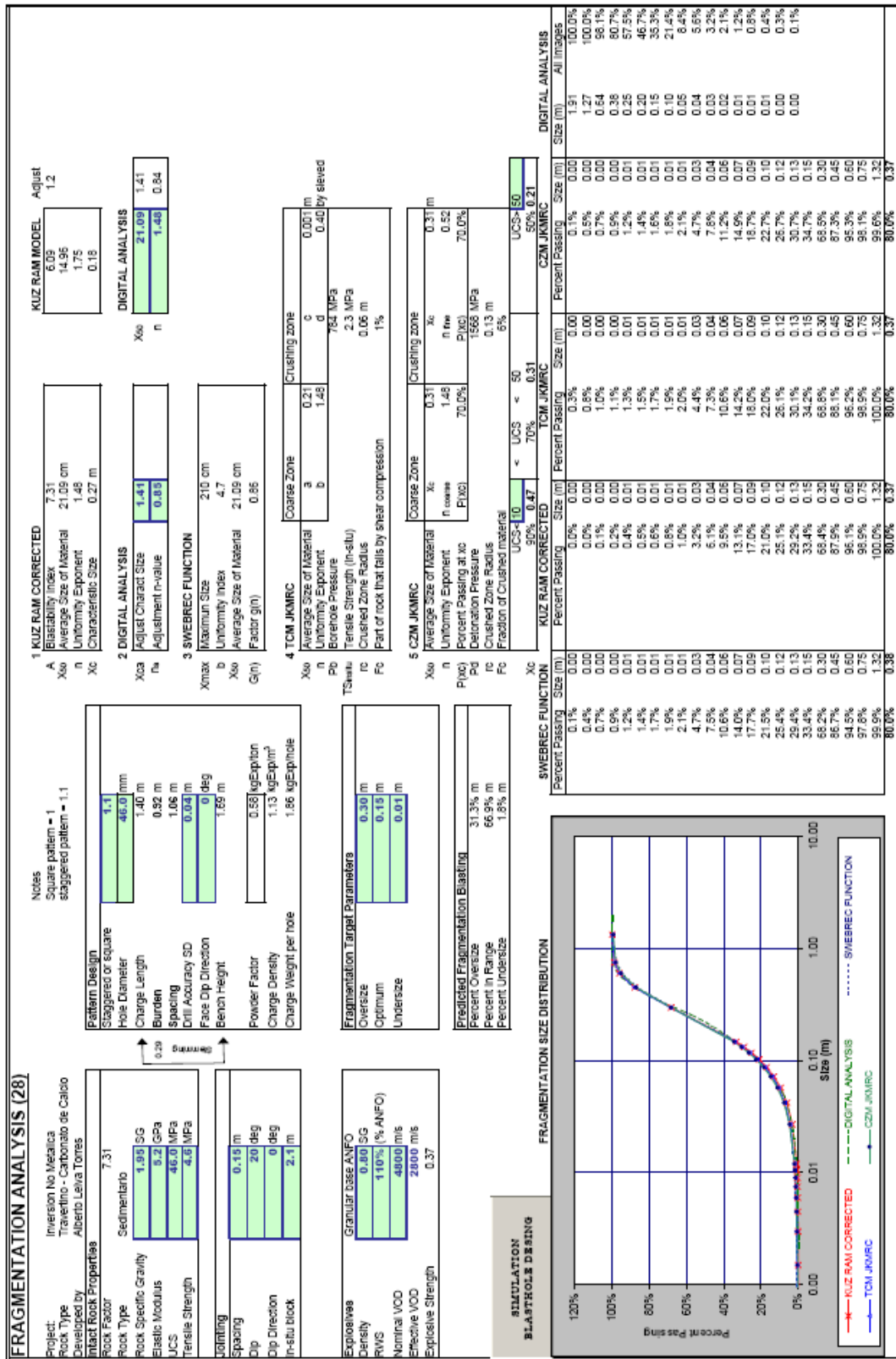


Figura 3.2 RESULTADOS DEL ANÁLISIS DE FRAGMENTACIÓN PARA 50mm DE DIAMETRO DE PERFORACION

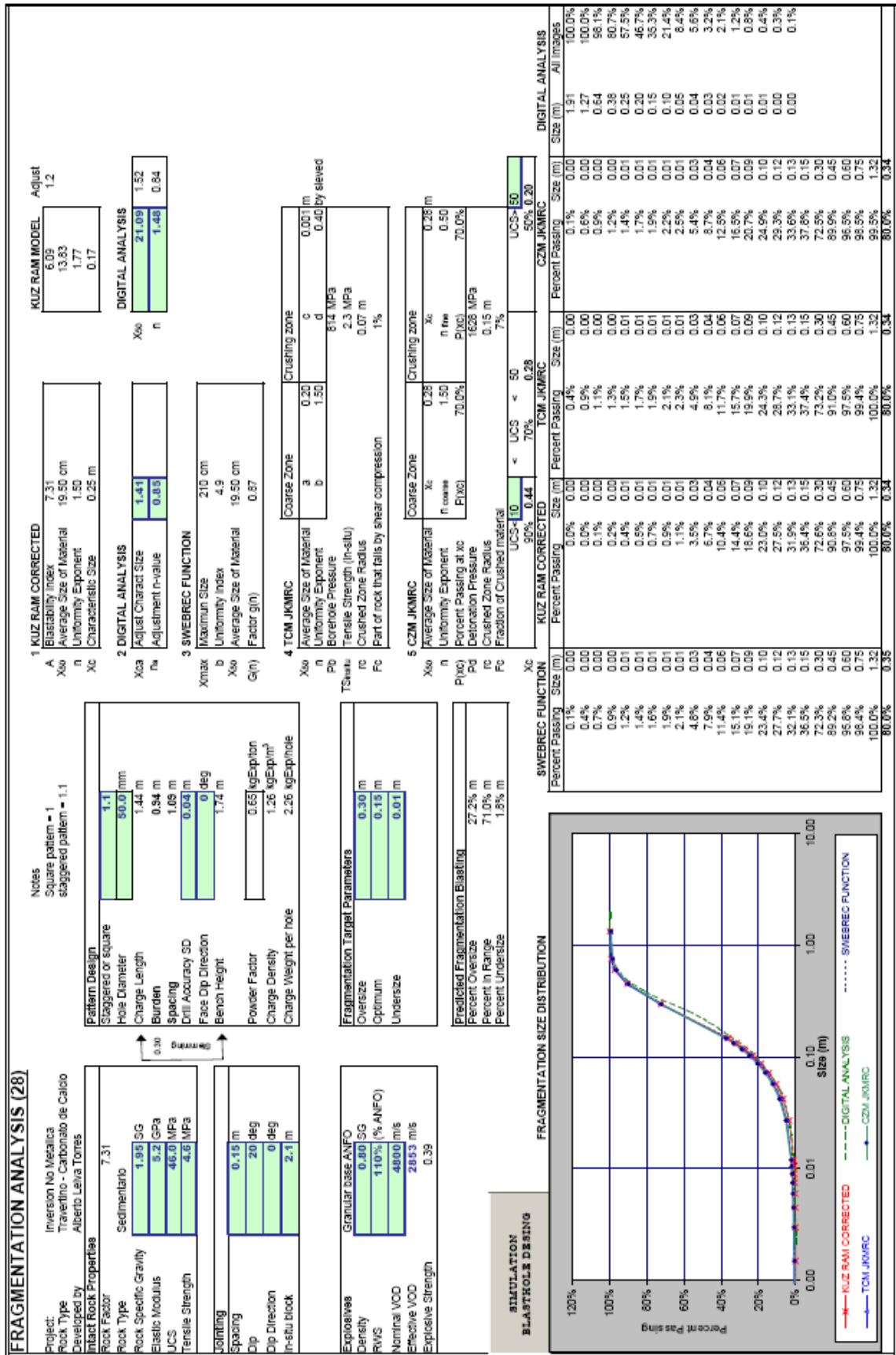


Figura 3.3 RESULTADOS DEL ANÁLISIS DE FRAGMENTACIÓN PARA 54mm DE DIÁMETRO DE PERFORACION

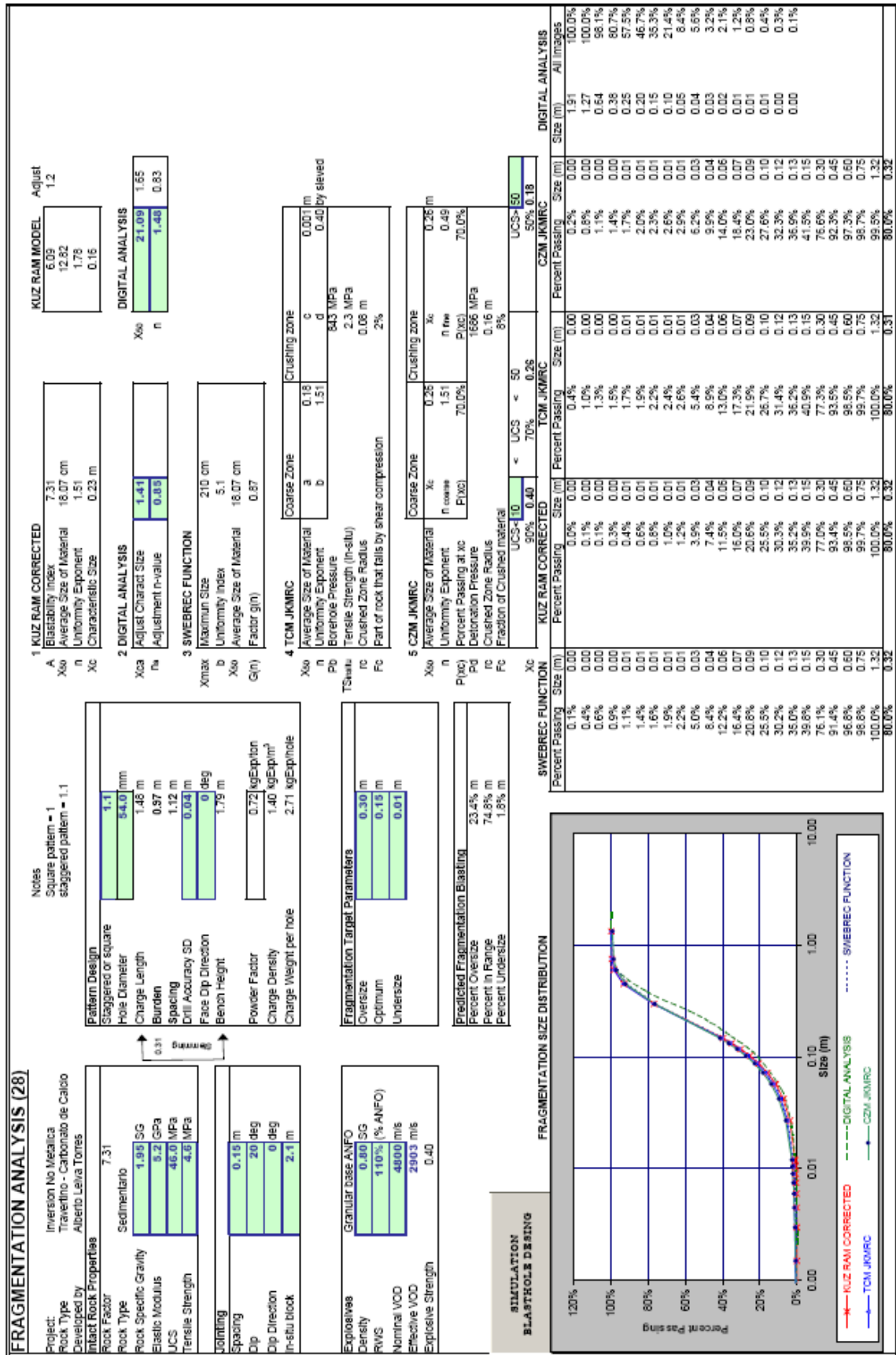


Figura 3.4 RESULTADOS DEL ANÁLISIS DE FRAGMENTACIÓN PARA 58mm DE DIAMETRO DE PERFORACION

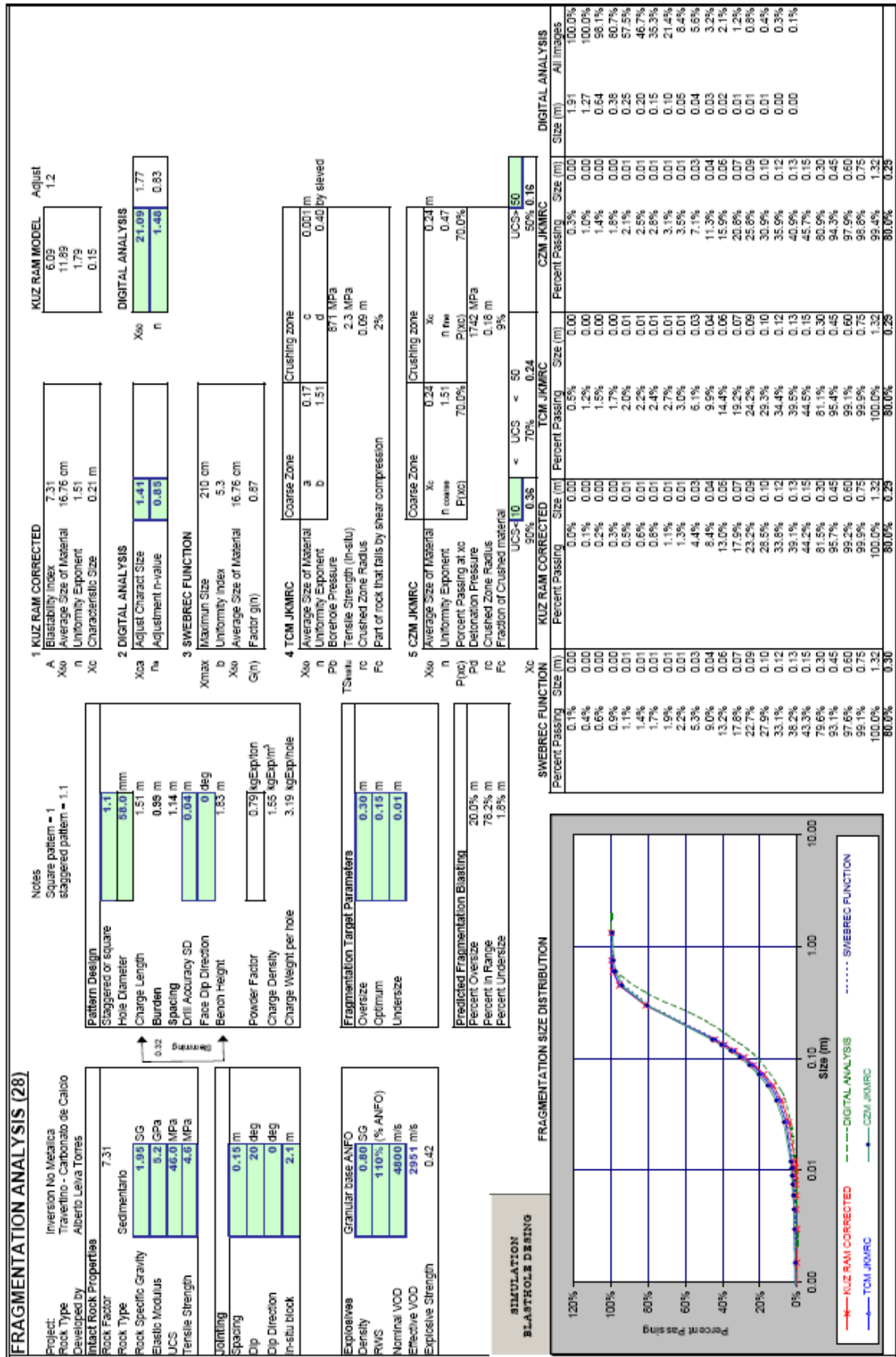


Figura 3.5 RESULTADOS DEL ANÁLISIS DE FRAGMENTACIÓN PARA 62mm DE DIAMETRO DE PERFORACION

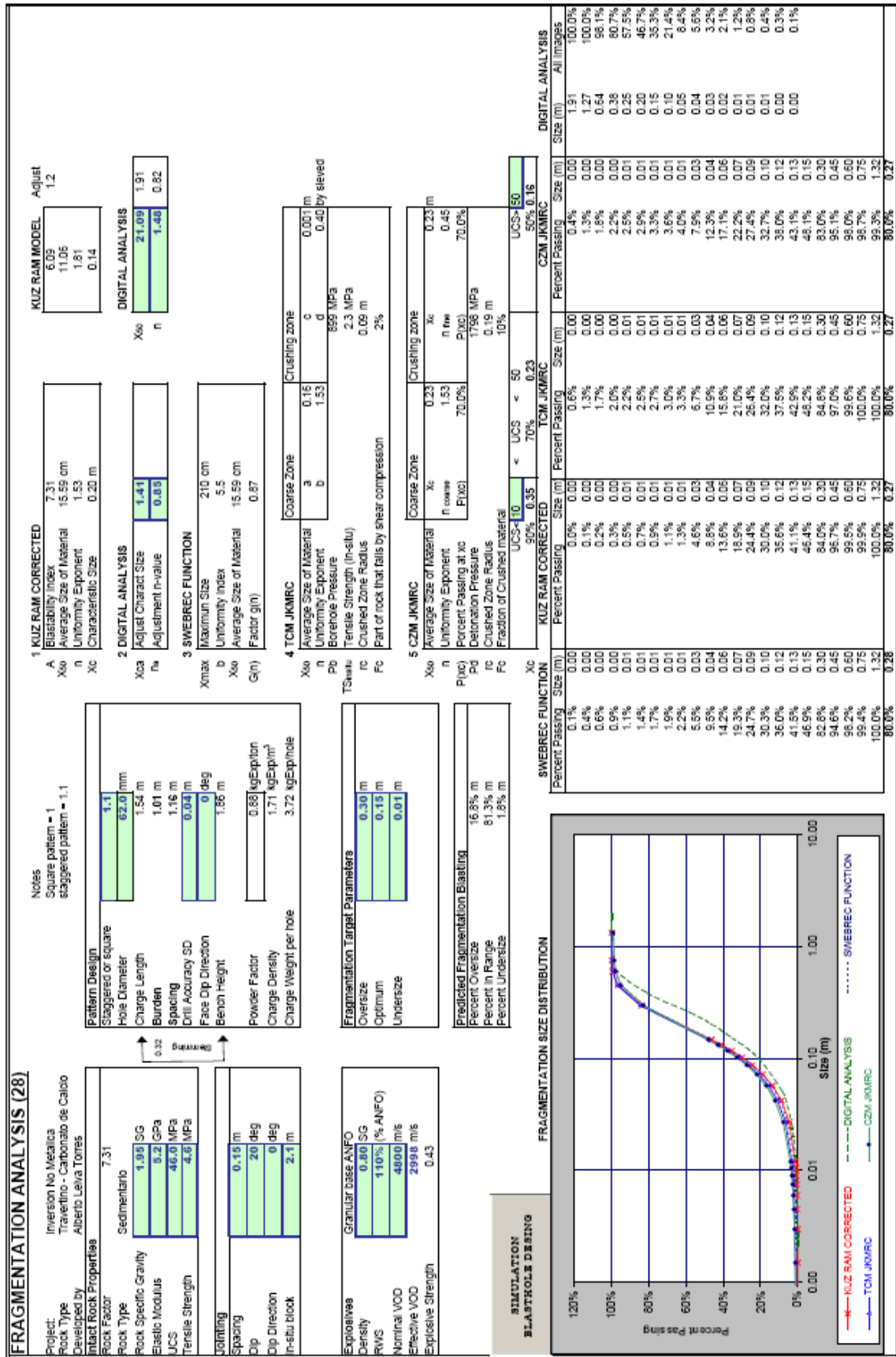


Figura 3.6 RESULTADOS DEL ANÁLISIS DE FRAGMENTACIÓN PARA 66mm DE DIAMETRO DE PERFORACION

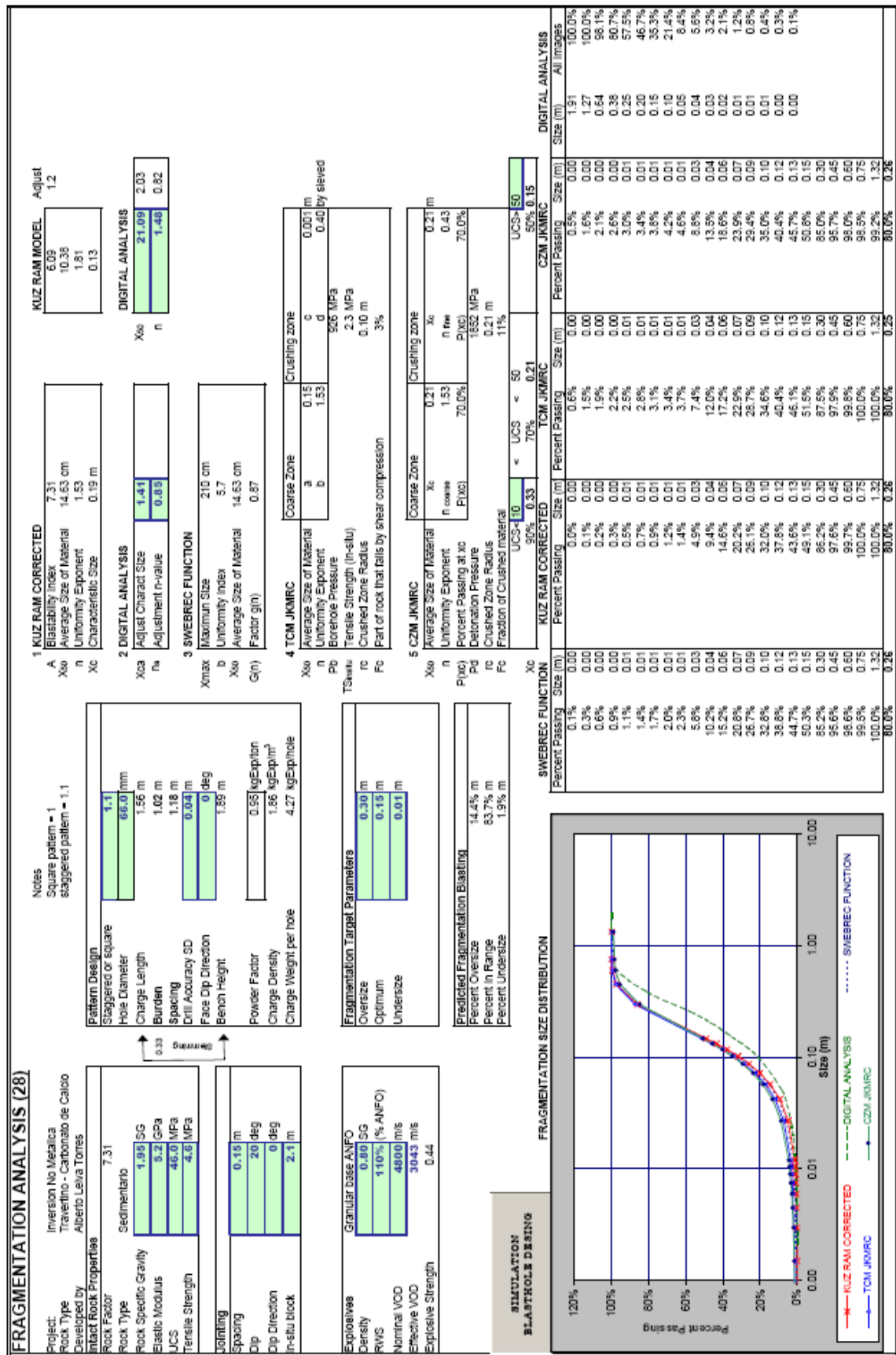


Figura 3.7 RESULTADOS DEL ANÁLISIS DE FRAGMENTACIÓN PARA 70mm DE DIAMETRO DE PERFORACION

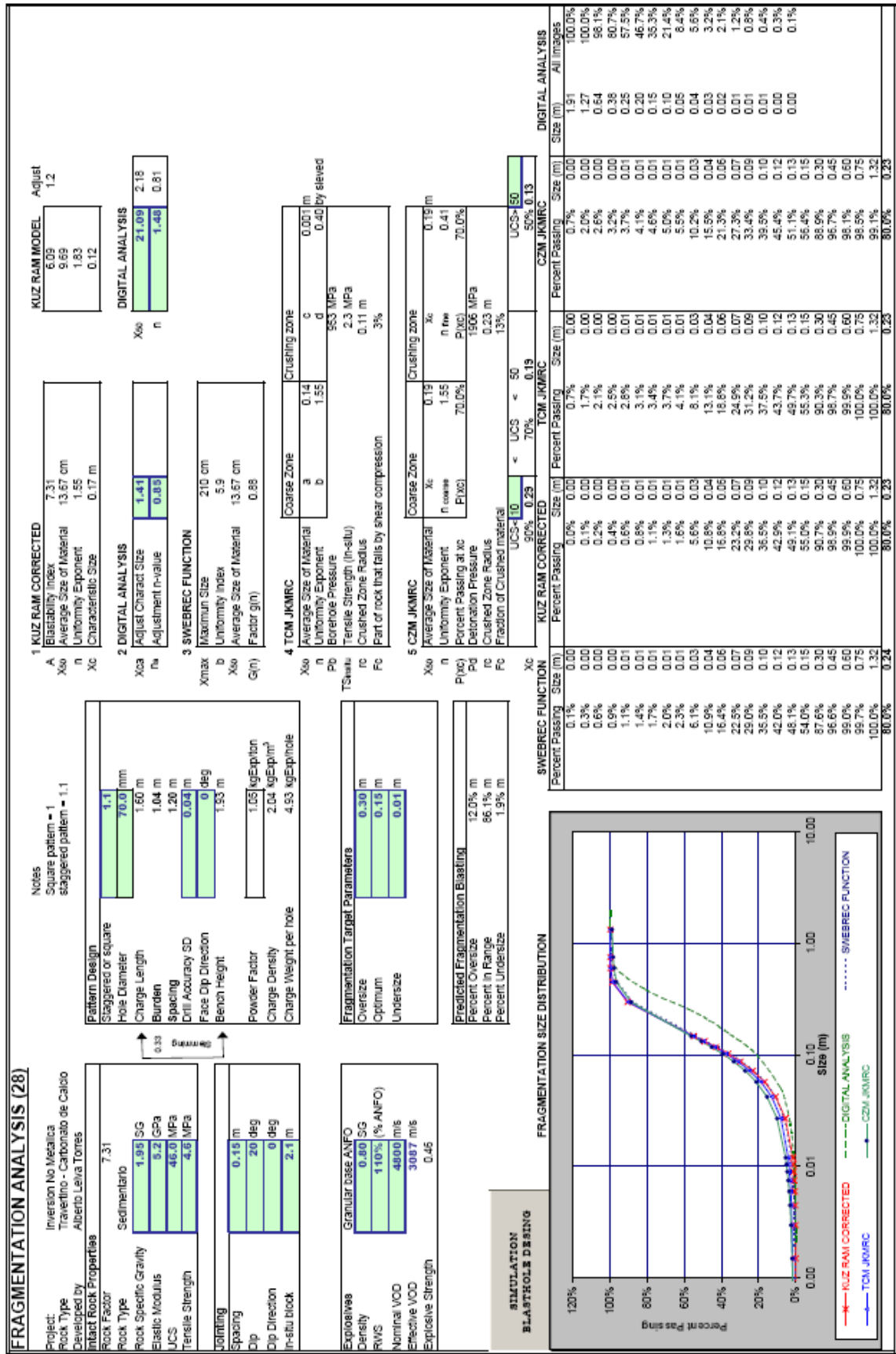


Figura 3.8 RESULTADOS DEL ANÁLISIS DE FRAGMENTACIÓN PARA 74mm DE DIAMETRO DE PERFORACION

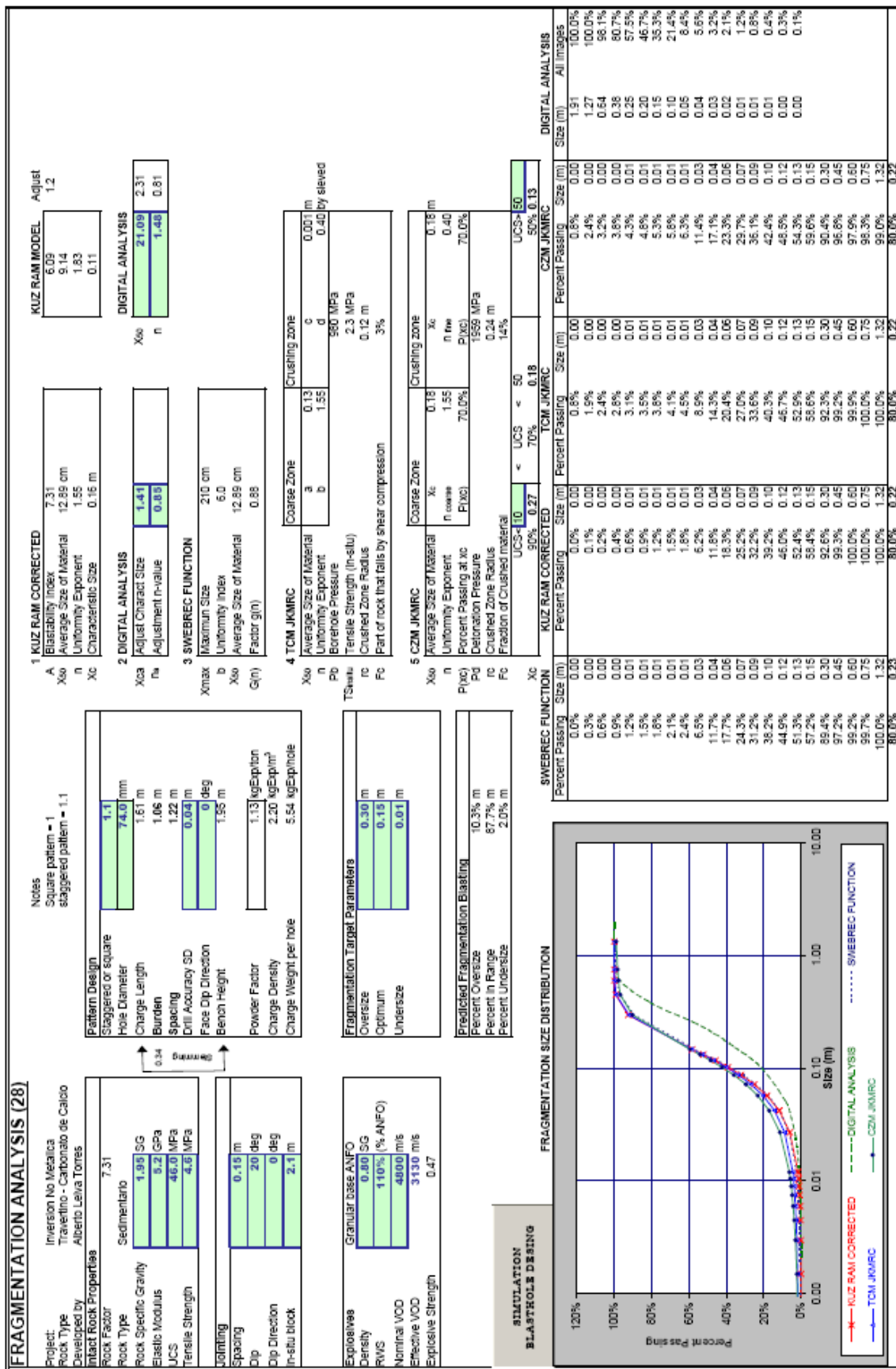


Figura 3.9 RESULTADOS DEL ANÁLISIS DE FRAGMENTACIÓN PARA 78mm DE DIAMETRO DE PERFORACION

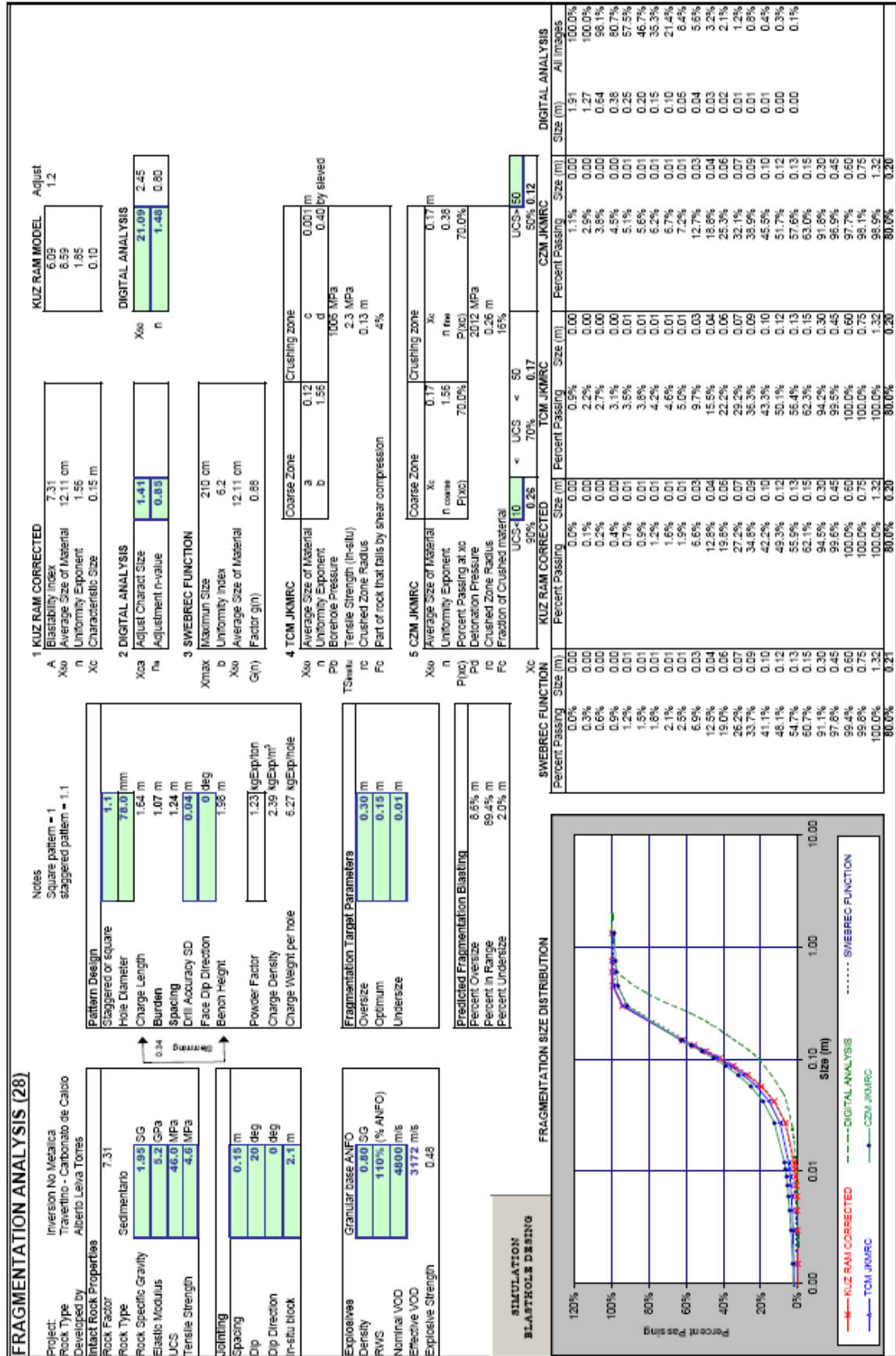
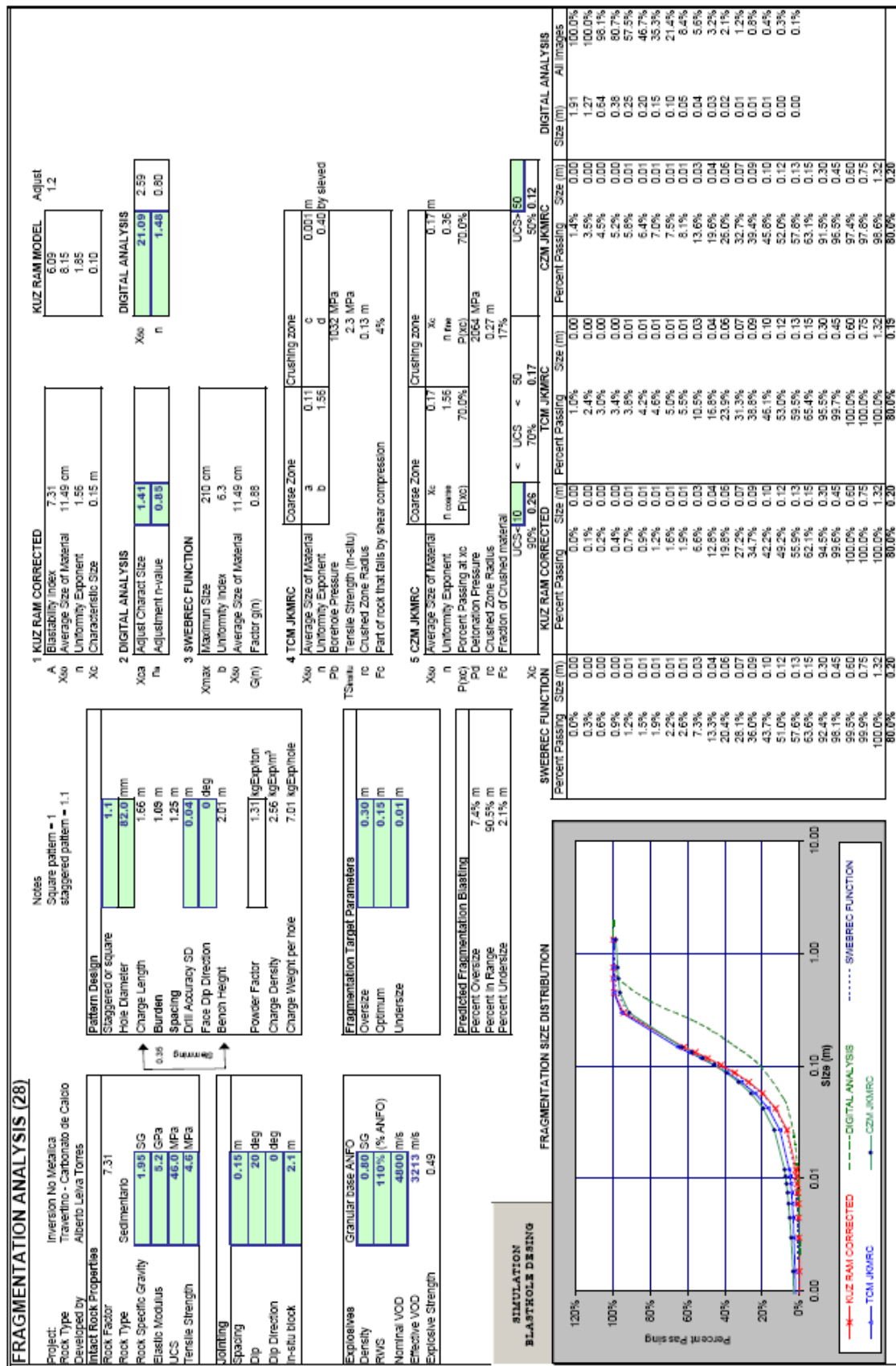


Figura 3.10 RESULTADOS DEL ANÁLISIS DE FRAGMENTACIÓN PARA 82mm DE DIAMETRO DE PERFORACION



ANEXO 4: ANALISIS DE COSTO VOLADURA Y CHANCADO MODELO DE BOND

Figura 4.1 Costos de Voladura y Chancado para diseño con 46mm de diámetro de perforación.

ECUACION DE CONMINUCION DE BOND

Costo Explosivo	0.74	\$/kgExp	
1 Kcal =	1.163	watt hours	Dato de conversion de energia
rws =	1.1		Manual del Explosivo
Factor Potencia	0.58	KgExp/Ton	
Energia Explosivo	1003	Cal/grExp	Manual del Explosivo
Energia Explosivo	1.28	kWh/KgExp	Nota Wi =[KWh/short ton]
Energia Voladura	0.74	kWh/Long Ton	1short ton=(2000/2240) long ton

	FEED F ₈₀ (milímetros)	PRODUCT P ₈₀ (milímetros)	W(Calc) kWh/Long Ton	W(Actual) kWh/Long Ton	Apparent Efficiency	Costo \$/kWh	Costo \$/ Ton	Wi KWh/Short Ton
Blasting	2100	378	0.74	0.74	100%	0.57	0.42	70.60
Crushing	378	6.35	1.95	1.95	100%	0.10	0.19	15.90
Grinding	6.35	6.35	0.00	0.00	0%	0.10	0.00	0.00
TOTAL	2100	6.35	2.69	2.69			0.61	

Figura 4.2 Costos de Voladura y Chancado para diseño con 50mm de diámetro de perforación.

ECUACION DE CONMINUCION DE BOND

Costo Explosivo	0.74	\$/kgExp	
1 Kcal =	1.163	watt hours	Dato de conversion de energia
rws =	1.1		Manual del Explosivo
Factor Potencia	0.65	KgExp/Ton	
Energia Explosivo	1003	Cal/grExp	Manual del Explosivo
Energia Explosivo	1.28	kWh/KgExp	Nota Wi =[KWh/short ton]
Energia Voladura	0.83	kWh/Long Ton	1short ton=(2000/2240) long ton

	FEED F ₈₀ (milímetros)	PRODUCT P ₈₀ (milímetros)	W(Calc) kWh/Long Ton	W(Actual) kWh/Long Ton	Apparent Efficiency	Costo \$/kWh	Costo \$/ Ton	Wi KWh/Short Ton
Blasting	2100	349	0.83	0.83	100%	0.57	0.48	73.97
Crushing	349	6.35	1.93	1.93	100%	0.10	0.19	15.90
Grinding	6.35	6.35	0.00	0.00	0%	0.10	0.00	0.00
TOTAL	2100	6.35	2.76	2.76			0.66	

Figura 4.3 Costos de Voladura y Chancado para diseño con 54mm de diámetro de perforación.

ECUACION DE CONMINUCION DE BOND

Costo Explosivo	0.74	\$/kgExp	
1 Kcal =	1.163	watt hours	Dato de conversion de energia
rws =	1.1		Manual del Explosivo
Factor Potencia	0.72	KgExp/Ton	
Energia Explosivo	1003	Cal/grExp	Manual del Explosivo
Energia Explosivo	1.28	kWh/KgExp	Nota Wi =[KWh/short ton]
Energia Voladura	0.92	kWh/Long Ton	1short ton=(2000/2240) long ton

	FEED F ₈₀ (milímetros)	PRODUCT P ₈₀ (milímetros)	W(Calc) kWh/Long Ton	W(Actual) kWh/Long Ton	Apparent Efficiency	Costo \$/kWh	Costo \$/ Ton	Wi KWh/Short Ton
Blasting	2100	323	0.92	0.92	100%	0.57	0.53	76.87
Crushing	323	6.35	1.92	1.92	100%	0.10	0.19	15.90
Grinding	6.35	6.35	0.00	0.00	0%	0.10	0.00	0.00
TOTAL	2100	6.35	2.84	2.84			0.72	

Figura 4.4 Costos de Voladura y Chancado para diseño con 58mm de diámetro de perforación.

ECUACION DE CONMINUCION DE BOND

Costo Explosivo	0.74	\$/kgExp
1 Kcal =	1.163	watt hours
rws =	1.1	
Factor Potencia	0.79	KgExp/Ton
Energia Explosivo	1003	Cal/grExp
Energia Explosivo	1.28	kWh/KgExp
Energia Voladura	1.01	kWh/Long Ton

Dato de conversion de energia
Manual del Explosivo
Manual del Explosivo
Nota Wi =[KWh/short ton]
1short ton=(2000/2240) long ton

	FEED F ₈₀ (milímetros)	PRODUCT P ₈₀ (milímetros)	W(Calc) kWh/Long Ton	W(Actual) kWh/Long Ton	Apparent Efficiency	Costo \$/kWh	Costo \$/ Ton	Wi KWh/Short Ton
Blasting	2100	300	1.01	1.01	100%	0.57	0.58	79.36
Crushing	300	6.35	1.91	1.91	100%	0.10	0.19	15.90
Grinding	6.35	6.35	0.00	0.00	0%	0.10	0.00	0.00
TOTAL	2100	6.35	2.92	2.92			0.77	

Figura 4.5 Costos de Voladura y Chancado para diseño con 62mm de diámetro de perforación.

ECUACION DE CONMINUCION DE BOND

Costo Explosivo	0.74	\$/kgExp
1 Kcal =	1.163	watt hours
rws =	1.1	
Factor Potencia	0.88	KgExp/Ton
Energia Explosivo	1003	Cal/grExp
Energia Explosivo	1.28	kWh/KgExp
Energia Voladura	1.13	kWh/Long Ton

Dato de conversion de energia
Manual del Explosivo
Manual del Explosivo
Nota Wi =[KWh/short ton]
1short ton=(2000/2240) long ton

	FEED F ₈₀ (milímetros)	PRODUCT P ₈₀ (milímetros)	W(Calc) kWh/Long Ton	W(Actual) kWh/Long Ton	Apparent Efficiency	Costo \$/kWh	Costo \$/ Ton	Wi KWh/Short Ton
Blasting	2100	278	1.13	1.13	100%	0.57	0.65	83.59
Crushing	278	6.35	1.90	1.90	100%	0.10	0.19	15.90
Grinding	6.35	6.35	0.00	0.00	0%	0.10	0.00	0.00
TOTAL	2100	6.35	3.03	3.03			0.83	

Figura 4.6 Costos de Voladura y Chancado para diseño con 66mm de diámetro de perforación.

ECUACION DE CONMINUCION DE BOND

Costo Explosivo	0.74	\$/kgExp
1 Kcal =	1.163	watt hours
rws =	1.1	
Factor Potencia	0.95	KgExp/Ton
Energia Explosivo	1003	Cal/grExp
Energia Explosivo	1.28	kWh/KgExp
Energia Voladura	1.22	kWh/Long Ton

Dato de conversion de energia
Manual del Explosivo
Manual del Explosivo
Nota Wi =[KWh/short ton]
1short ton=(2000/2240) long ton

	FEED F ₈₀ (milímetros)	PRODUCT P ₈₀ (milímetros)	W(Calc) kWh/Long Ton	W(Actual) kWh/Long Ton	Apparent Efficiency	Costo \$/kWh	Costo \$/ Ton	Wi KWh/Short Ton
Blasting	2100	261	1.22	1.22	100%	0.57	0.70	85.93
Crushing	261	6.35	1.89	1.89	100%	0.10	0.19	15.90
Grinding	6.35	6.35	0.00	0.00	0%	0.10	0.00	0.00
TOTAL	2100	6.35	3.11	3.11			0.88	

Figura 4.7 Costos de Voladura y Chancado para diseño con 70mm de diámetro de perforación.

ECUACION DE CONMINUCION DE BOND

Costo Explosivo	0.74	\$/kgExp
1 Kcal =	1.163	watt hours
rws =	1.1	
Factor Potencia	1.05	KgExp/Ton
Energia Explosivo	1003	Cal/grExp
Energia Explosivo	1.28	kWh/KgExp
Energia Voladura	1.35	kWh/Long Ton

Dato de conversión de energía
Manual del Explosivo
Manual del Explosivo
Nota $W_i = [KWh/short\ ton]$
1short ton=(2000/2240) long ton

	FEED F ₈₀ (milímetros)	PRODUCT P ₈₀ (milímetros)	W(Calc) kWh/Long Ton	W(Actual) kWh/Long Ton	Apparent Efficiency	Costo \$/kWh	Costo \$/ Ton	Wi KWh/Short Ton
Blasting	2100	243	1.35	1.35	100%	0.57	0.77	90.03
Crushing	243	6.35	1.87	1.87	100%	0.10	0.18	15.90
Grinding	6.35	6.35	0.00	0.00	0%	0.10	0.00	0.00
TOTAL	2100	6.35	3.22	3.22			0.96	

Figura 4.8 Costos de Voladura y Chancado para diseño con 74mm de diámetro de perforación.

ECUACION DE CONMINUCION DE BOND

Costo Explosivo	0.74	\$/kgExp
1 Kcal =	1.163	watt hours
rws =	1.1	
Factor Potencia	1.13	KgExp/Ton
Energia Explosivo	1003	Cal/grExp
Energia Explosivo	1.28	kWh/KgExp
Energia Voladura	1.45	kWh/Long Ton

Dato de conversión de energía
Manual del Explosivo
Manual del Explosivo
Nota $W_i = [KWh/short\ ton]$
1short ton=(2000/2240) long ton

	FEED F ₈₀ (milímetros)	PRODUCT P ₈₀ (milímetros)	W(Calc) kWh/Long Ton	W(Actual) kWh/Long Ton	Apparent Efficiency	Costo \$/kWh	Costo \$/ Ton	Wi KWh/Short Ton
Blasting	2100	229	1.45	1.45	100%	0.57	0.83	92.62
Crushing	229	6.35	1.86	1.86	100%	0.10	0.18	15.90
Grinding	6.35	6.35	0.00	0.00	0%	0.10	0.00	0.00
TOTAL	2100	6.35	3.31	3.31			1.01	

Figura 4.9 Costos de Voladura y Chancado para diseño con 78mm de diámetro de perforación.

ECUACION DE CONMINUCION DE BOND

Costo Explosivo	0.74	\$/kgExp
1 Kcal =	1.163	watt hours
rws =	1.1	
Factor Potencia	1.23	KgExp/Ton
Energia Explosivo	1003	Cal/grExp
Energia Explosivo	1.28	kWh/KgExp
Energia Voladura	1.58	kWh/Long Ton

Dato de conversión de energía
Manual del Explosivo
Manual del Explosivo
Nota $W_i = [KWh/short\ ton]$
1short ton=(2000/2240) long ton

	FEED F ₈₀ (milímetros)	PRODUCT P ₈₀ (milímetros)	W(Calc) kWh/Long Ton	W(Actual) kWh/Long Ton	Apparent Efficiency	Costo \$/kWh	Costo \$/ Ton	Wi KWh/Short Ton
Blasting	2100	215	1.58	1.58	100%	0.57	0.91	96.18
Crushing	215	6.35	1.85	1.85	100%	0.10	0.18	15.90
Grinding	6.35	6.35	0.00	0.00	0%	0.10	0.00	0.00
TOTAL	2100	6.35	3.43	3.43			1.09	

Figura 4.10 Costos de Voladura y Chancado para diseño con 82mm de diámetro de perforación.

ECUACION DE CONMINUCION DE BOND

Costo Explosivo	0.74	\$/kgExp
1 Kcal =	1.163	watt hours
rws =	1.1	
Factor Potencia	1.31	KgExp/Ton
Energia Explosivo	1003	Cal/grExp
Energia Explosivo	1.28	kWh/KgExp
Energia Voladura	1.68	kWh/Long Ton

Dato de conversion de energia
Manual del Explosivo

Manual del Explosivo

Nota Wi =[KWh/short ton]

1short ton=(2000/2240) long ton

	FEED F ₈₀ (milímetros)	PRODUCT P ₈₀ (milímetros)	W(Calc) kWh/Long Ton	W(Actual) kWh/Long Ton	Apparent Efficiency	Costo \$/kWh	Costo \$/ Ton	Wi KWh/Short Ton
Blasting	2100	204	1.68	1.68	100%	0.57	0.96	98.45
Crushing	204	6.35	1.84	1.84	100%	0.10	0.18	15.90
Grinding	6.35	6.35	0.00	0.00	0%	0.10	0.00	0.00
TOTAL	2100	6.35	3.52	3.52			1.14	



ANEXO 5: EVALUACIÓN DEL VAN Y TIR ECONOMICO FINANCIERO

Figura 5.1 Análisis del VAN y TIR para un diseño de 46mm de diámetro de perforación. Sin proyecto.

NET PRESENT VALUE ANALYSIS					
VANF	\$0	VANE	\$0	Ko= COSTO PONDERADO OPORTUNIDAD NOMINAL	1.2% FINANCIERO
TVRF NOMINAL	0.0%	TVRE NOMINAL	0.00%	K'= COSTO PONDERADO DE CAPITAL NOMINAL	1.2% ECONOMICO
RATIO B/C	1.5	RATIO B/C	1.5	T= IMPUESTO	30%
VIDA PROYECTO	131 Meses			TOTAL DE INVERSION	\$0 Dolares
RESERVAS	1,810,944 Tn Material				

Figura 5.2 Análisis del VAN y TIR para un diseño de 50mm de diámetro de perforación.

NET PRESENT VALUE ANALYSIS					
VANF	\$1,269	VANE	-\$882	Ko= COSTO PONDERADO OPORTUNIDAD NOMINAL	0.9% FINANCIERO
TVRF NOMINAL	3.6%	TVRE NOMINAL	2.83%	K'= COSTO PONDERADO DE CAPITAL NOMINAL	0.8% ECONOMICO
RATIO B/C	1.5	RATIO B/C	1.5	T= IMPUESTO	30%
VIDA PROYECTO	120 Meses			TOTAL DE INVERSION	\$124,029 Dolares
RESERVAS	1,810,944 Tn Material				

Figura 5.3 Análisis del VAN y TIR para un diseño de 54mm de diámetro de perforación.

NET PRESENT VALUE ANALYSIS					
VANF	\$63,633	VANE	\$50,318	Ko= COSTO PONDERADO OPORTUNIDAD NOMINAL	0.9% FINANCIERO
TVRF NOMINAL	3.6%	TVRE NOMINAL	2.81%	K'= COSTO PONDERADO DE CAPITAL NOMINAL	0.8% ECONOMICO
RATIO B/C	1.5	RATIO B/C	1.5	T= IMPUESTO	30%
VIDA PROYECTO	111 Meses			TOTAL DE INVERSION	\$131,457 Dolares
RESERVAS	1,810,944 Tn Material				

Figura 5.4 Análisis del VAN y TIR para un diseño de 58mm de diámetro de perforación.

NET PRESENT VALUE ANALYSIS					
VANF	\$105,303	VANE	\$98,308	Ko= COSTO PONDERADO OPORTUNIDAD NOMINAL	0.9% FINANCIERO
TVRF NOMINAL	3.6%	TVRE NOMINAL	2.79%	K'= COSTO PONDERADO DE CAPITAL NOMINAL	0.8% ECONOMICO
RATIO B/C	1.5	RATIO B/C	1.5	T= IMPUESTO	30%
VIDA PROYECTO	104 Meses			TOTAL DE INVERSION	\$138,202 Dolares
RESERVAS	1,810,944 Tn Material				

Figura 5.5 Análisis del VAN y TIR para un diseño de 62mm de diámetro de perforación.

NET PRESENT VALUE ANALYSIS					
VANF	\$113,119	VANE	\$102,538	Ko= COSTO PONDERADO OPORTUNIDAD NOMINAL	0.9% FINANCIERO
TVRF NOMINAL	3.5%	TVRE NOMINAL	2.76%	K'= COSTO PONDERADO DE CAPITAL NOMINAL	0.8% ECONOMICO
RATIO B/C	1.5	RATIO B/C	1.5	T= IMPUESTO	30%
VIDA PROYECTO	99 Meses			TOTAL DE INVERSION	\$144,516 Dolares
RESERVAS	1,810,944 Tn Material				

Figura 5.6 Análisis del VAN y TIR para un diseño de 66mm de diámetro de perforación.

<u>NET PRESENT VALUE ANALYSIS</u>					
VANF	\$127,799	VANE	\$113,968	K _o = COSTO PONDERADO OPORTUNIDAD NOMINAL	0.9% FINANCIERO
TVRF NOMINAL	3.5%	TVRE NOMINAL	2.74%	K [*] = COSTO PONDERADO DE CAPITAL NOMINAL	0.8% ECONOMICO
RATIO B/C	1.5	RATIO B/C	1.5	T= IMPUESTO	30%
VIDA PROYECTO	94 Meses			TOTAL DE INVERSION	\$150,735 Dolares
RESERVAS	1,810,944 Tn Material				

Figura 5.7 Análisis del VAN y TIR para un diseño de 70mm de diámetro de perforación.

<u>NET PRESENT VALUE ANALYSIS</u>					
VANF	\$121,683	VANE	\$103,360	K _o = COSTO PONDERADO OPORTUNIDAD NOMINAL	0.9% FINANCIERO
TVRF NOMINAL	3.5%	TVRE NOMINAL	2.70%	K [*] = COSTO PONDERADO DE CAPITAL NOMINAL	0.8% ECONOMICO
RATIO B/C	1.4	RATIO B/C	1.5	T= IMPUESTO	30%
VIDA PROYECTO	89 Meses			TOTAL DE INVERSION	\$158,003 Dolares
RESERVAS	1,810,944 Tn Material				

Figura 5.8 Análisis del VAN y TIR para un diseño de 74mm de diámetro de perforación.

<u>NET PRESENT VALUE ANALYSIS</u>					
VANF	\$116,219	VANE	\$94,228	K _o = COSTO PONDERADO OPORTUNIDAD NOMINAL	0.9% FINANCIERO
TVRF NOMINAL	3.4%	TVRE NOMINAL	2.67%	K [*] = COSTO PONDERADO DE CAPITAL NOMINAL	0.8% ECONOMICO
RATIO B/C	1.4	RATIO B/C	1.5	T= IMPUESTO	30%
VIDA PROYECTO	85 Meses			TOTAL DE INVERSION	\$164,197 Dolares
RESERVAS	1,810,944 Tn Material				

Figura 5.9 Análisis del VAN y TIR para un diseño de 78mm de diámetro de perforación.

<u>NET PRESENT VALUE ANALYSIS</u>					
VANF	\$86,891	VANE	\$80,923	K _o = COSTO PONDERADO OPORTUNIDAD NOMINAL	0.9% FINANCIERO
TVRF NOMINAL	3.4%	TVRE NOMINAL	2.63%	K [*] = COSTO PONDERADO DE CAPITAL NOMINAL	0.8% ECONOMICO
RATIO B/C	1.4	RATIO B/C	1.5	T= IMPUESTO	30%
VIDA PROYECTO	82 Meses			TOTAL DE INVERSION	\$170,530 Dolares
RESERVAS	1,810,944 Tn Material				

Figura 5.10 Análisis del VAN y TIR para un diseño de 82mm de diámetro de perforación.

<u>NET PRESENT VALUE ANALYSIS</u>					
VANF	\$67,435	VANE	\$38,008	K _o = COSTO PONDERADO OPORTUNIDAD NOMINAL	0.9% FINANCIERO
TVRF NOMINAL	3.4%	TVRE NOMINAL	2.58%	K [*] = COSTO PONDERADO DE CAPITAL NOMINAL	0.8% ECONOMICO
RATIO B/C	1.4	RATIO B/C	1.4	T= IMPUESTO	30%
VIDA PROYECTO	79 Meses			TOTAL DE INVERSION	\$176,943 Dolares
RESERVAS	1,810,944 Tn Material				