

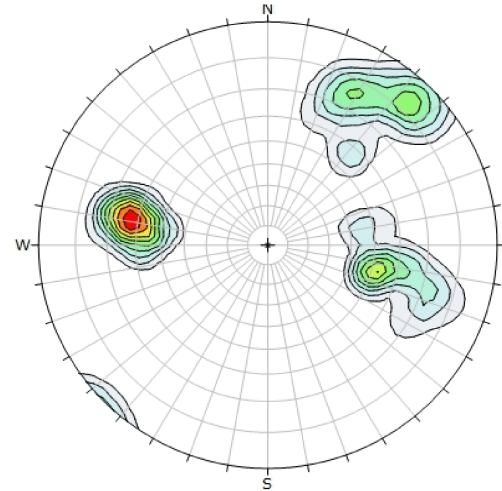
ANEXO 13
ESTACIONES GEOTÉCNICAS Y
GEOMECÁNICAS

FICHA DE ESTACIÓN GEOMECÁNICA 01

COORDENADAS: X: 340311.694 Y: 8477039.384 Z: 2541.000 ESTACIÓN Nº: 1
 FECHA: dic-15 Calidad de afloramiento:

| MEDIDAS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---------------|-----|-----|-----|-----|-----|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Tipo de Plano | E1 | J1 | J2 | J3 | J4 | J5 | E2 | J6 | J7 | J8 | J9 | J10 | E3 | J11 | J12 | J13 | J14 | J15 | J16 |
| Azímüt | 90 | 103 | 98 | 104 | 101 | 103 | 287 | 280 | 285 | 280 | 260 | 281 | 210 | 225 | 220 | 225 | 210 | 195 | 100 |
| Buzamiento | 58 | 66 | 52 | 60 | 65 | 67 | 52 | 55 | 65 | 58 | 44 | 53 | 75 | 87 | 63 | 87 | 70 | 68 | 059 |
| ESPACIADO | | | | | | | | | | | | | | | | | | | |
| > 2000 mm | | | | | | | | | | | | | | | | | | | |
| 600 - 2000 mm | | | | X | | | | | | | | | | | | X | | | |
| 200 - 600 mm | X | | X | X | | X | X | X | | X | X | X | X | | X | | X | X | X |
| 60 - 200 mm | | X | | | | | | X | X | | | | | X | | | | | |
| < 60 mm | | | | | | | | | | | | | | | | | | | |
| CONTINUIDAD | | | | | | | | | | | | | | | | | | | |
| < 1 m | | | | | | | X | X | X | X | X | X | | | | | | | |
| 1-3 m | X | X | X | X | X | X | | | | | | | X | X | X | X | X | X | X |
| 3-10 m | | | | | | | | | | | | | | | | | | | |
| 10-20 m | | | | | | | | | | | | | | | | | | | |
| >20 m | | | | | | | | | | | | | | | | | | | |
| APERTURA | | | | | | | | | | | | | | | | | | | |
| Nada | | | | | | | | | | | | | | | | | | | |
| < 0.1 mm | | | | | | | X | | | | | | | X | | | | | |
| 0.1-1.0 mm | | X | | | X | | | X | X | | | X | | X | | X | X | X | X |
| 1-5 mm | X | X | X | X | | X | | | | X | X | | | | X | X | X | | X |
| > 5 mm | | | | | | | | | | | | | X | | | | | | X |
| RUGOSIDAD | | | | | | | | | | | | | | | | | | | |
| Ondulación | S | S | O | S | LR | LR | O | O | O | O | O | O | S | O | O | O | O | LR | O |
| JRC | 2 | 2 | 5 | 2 | 8 | 8 | 5 | 5 | 5 | 5 | 5 | 5 | 2 | 5 | 5 | 5 | 5 | 8 | 5 |
| METOR. JUNTA | | | | | | | | | | | | | | | | | | | |
| Grado | III | III | III | III | III | III | III | III | III | III | III | III | II | II | II | II | II | II | II |
| AGUA | | | | | | | | | | | | | | | | | | | |
| Seco | | | | | | | | | | | | | | | | | | | |
| Liq. humedo | | | | X | | X | | | | X | X | X | | X | X | X | X | | X |
| Humedo | X | X | X | | X | | X | X | X | | | | X | | | | | | X |
| Goteando | | | | | | | | | | | | | | | | | | | |
| Fluyendo | | | | | | | | | | | | | | | | | | | |
| RELLENO | | | | | | | | | | | | | | | | | | | |
| Naturaleza | ox | ox | ox | ox | ox | ox | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe |
| Espesor mm | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |

LITOLOGIA: Metalimolita gris-marrón FORMACIÓN:
 METEORIZACION: Grado III RESISTENCIA: R4 = Dura



| Color | Density Concentrations |
|-------------|------------------------|
| Red | 0.00 - 0.20 |
| Orange | 0.20 - 0.40 |
| Yellow | 0.40 - 0.60 |
| Light Green | 0.60 - 0.80 |
| Green | 0.80 - 1.00 |
| Dark Green | 1.00 - 1.20 |
| Blue-Green | 1.20 - 1.40 |
| Blue | 1.40 - 1.60 |
| Dark Blue | 1.60 - 1.80 |
| Black | 1.80 - 2.00 |

Maximum Density: 17.0%

Contour Date: No Vectors

Contour Distribution: No Vectors

Counting Circle Size: 1.0%

Plot Mode: No Vectors

Vector Count: 50 (30 Brns)

Hemisphere: Lower

Projection: Equal Angle

| Martillo Schmidt | | | | | | Media |
|------------------|----|-----|-----|-----|-----|-------|
| Juntas | 98 | 102 | 105 | 96 | 106 | 48 |
| | 46 | 115 | 94 | 120 | 125 | 120 |
| JCS (Kg/cm2) | | | | | | 109 |

| | | |
|------------------|---------------------|----|
| Fracturas/metro | 2 | 16 |
| Juntas/m3 | Jv | 15 |
| Ensayo Tilt-test | φ _{básico} | 37 |

CARACTERIZACIÓN DEL MACIZO ROCOSO - RMR (Bieniawski 1989)

| OBTENCIÓN RMR BÁSICO | | VALORACIÓN MÍNIMA | | VALORACIÓN MÁXIMA | | |
|----------------------|-----------------------------------|--------------------------|------------------------|--------------------------|-----------------------|---|
| | | DATOS | VAL. | DATOS | VAL. | |
| RMR 1 | Resistencia a compr. simple (MPa) | Grado IV | 7 | Grado IV | 7 | |
| RMR 2 | Martillo de geólogo | | | | | |
| | Fracturas/metro lineal (λ) | 16 | | 15 | | |
| RMR 3 | RQD | 52 | | 56 | | |
| | Espaciado (mm) | 60 | 6 | 600 | 12 | |
| RMR 4 | Estado de las juntas | Persistencia | 1-3 m | 4 | < 1 m | 6 |
| | | Apertura | > 5 mm | 0 | 0.1-1.0 mm | 4 |
| | | Rugosidad | Suave | 1 | Ligeramente Rugosa | 3 |
| | | Relleno | Relleno blando > 5 mm | 0 | Relleno blando < 5 mm | 2 |
| | | Alteración | Moderadamente alterado | 3 | Ligeramente alterado | 5 |
| | Suma | | 8 | | 20 | |
| RMR 5 | Presencia de agua | Estado Húmedo | 7 | Estado Ligeram. húmedo | 10 | |
| | | Total | 39 | Total | 60 | |
| | | | | RMR Básico | 39 a 60 | |
| RMR 6 | F.C. Orientación Túnel | Perpend/en contra/Buz 70 | 12 | Perpend/en contra/Buz 70 | 5 | |
| | | | | RMR Total | 27 a 55 | |

CARACTERIZACIÓN DEL MACIZO ROCOSO - Q (Barton 2002)

| | | | | | | | | | | | |
|--------|------|---|------|-------|------|---|-----|--------|------|-----|------|
| RQD | 52 | - | 56 | Jr | 1 | - | 1 | Jw | 0.66 | - | 1 |
| Jn | 12 | - | 12 | Ja | 3 | - | 2 | SRF | 7.5 | - | 7.5 |
| RQD/Jn | 4.37 | - | 4.65 | Jr/Ja | 0.33 | - | 0.5 | Jw/SRF | 0.09 | - | 0.13 |
| | | | | Q | | | 0.1 | a | | 0.3 | |

FOTOGRAFIA DE LA ESTACIÓN GEOMECÁNICA

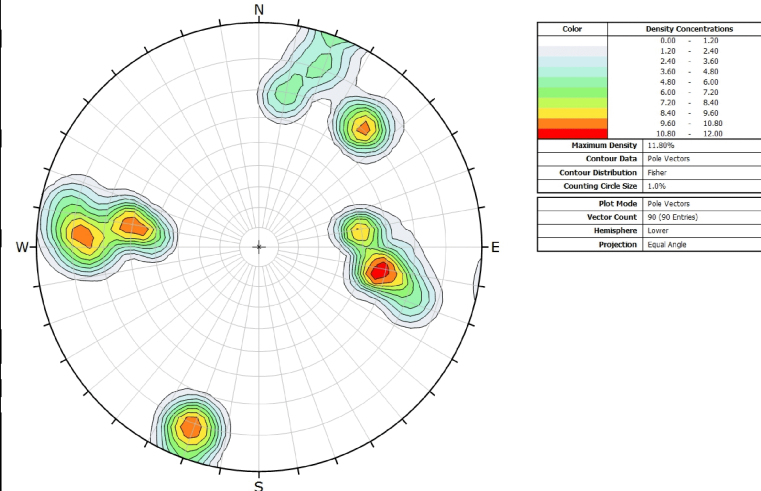


FICHA DE ESTACIÓN GEOMECÁNICA 02

COORDENADAS: X: 340351.428 Y: 8477122.232 Z: 2539.000 ESTACIÓN Nº: 2
 FECHA: dic-15 Calidad de afloramiento: Buena

| MEDIDAS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Tipo de Plano | E1 | J1 | J2 | J3 | J4 | J5 | E2 | J6 | J7 | J8 | J9 | J10 | E3 | J11 | J12 | J13 | J14 | J15 | J16 |
| Azímüt | 95 | 101 | 100 | 103 | 90 | 96 | 275 | 281 | 270 | 281 | 280 | 265 | 220 | 223 | 198 | 191 | 020 | 020 | 098 |
| Buzamiento | 50 | 60 | 65 | 80 | 70 | 78 | 65 | 55 | 70 | 58 | 45 | 50 | 73 | 69 | 81 | 68 | 83 | 81 | 058 |
| ESPACIADO | | | | | | | | | | | | | | | | | | | |
| > 2000 mm | | | | | | | | | | | | | | | | | | | |
| 600 - 2000 mm | | | X | X | | | | | | | | | | | | X | | | |
| 200 - 600 mm | X | X | | | X | X | X | X | X | X | X | X | | X | | | X | X | X |
| 60 - 200 mm | | | | | | | | | | | | | X | X | | | | | |
| < 60 mm | | | | | | | | | | | | | | | | | | | |
| CONTINUIDAD | | | | | | | | | | | | | | | | | | | |
| < 1 m | | | | | | | | | | | | | | | | | | | |
| 1-3 m | | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 3-10 m | X | X | X | X | X | X | | | | | | | | | | | | | |
| 10-20 m | | | | | | | | | | | | | | | | | | | |
| >20 m | | | | | | | | | | | | | | | | | | | |
| APERTURA | | | | | | | | | | | | | | | | | | | |
| Nada | | | | | | | | | | | | | | | | | | | |
| < 0.1 mm | | | | | | | | | | | | | | | | | | | |
| 0.1-1.0 mm | | X | | | X | | X | X | X | | | X | X | X | X | | X | X | X |
| 1-5 mm | X | | X | X | | X | | | | X | X | | | | | X | X | | X |
| > 5 mm | | | | | | | | | | | | | | | | | | | |
| RUGOSIDAD | | | | | | | | | | | | | | | | | | | |
| Ondulación | R | R | R | LR | LR | LR | O | O | O | O | O | O | R | R | O | LR | LR | LR | O |
| JRC | 15 | 15 | 15 | 10 | 10 | 10 | 7 | 7 | 7 | 7 | 7 | 7 | 15 | 15 | 7 | 10 | 10 | 10 | 7 |
| METOR. JUNTA | | | | | | | | | | | | | | | | | | | |
| Grado | II | II | II | II | II | II | III | III | III | III | III | III | II | II | II | II | II | II | II |
| AGUA | | | | | | | | | | | | | | | | | | | |
| Seco | | | | | | | X | X | X | X | X | X | | | | | | | |
| Liq. humedo | X | X | X | X | X | X | | | | | | | X | X | X | X | X | X | X |
| Humedo | | | | | | | | | | | | | | | | | | | |
| Goteando | | | | | | | | | | | | | | | | | | | |
| Fluyendo | | | | | | | | | | | | | | | | | | | |
| RELLENO | | | | | | | | | | | | | | | | | | | |
| Naturaleza | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe |
| Espesor mm | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |

LITOLOGIA: Metalimolita - metacuarcita FORMACIÓN:
 METEORIZACION: Grado III RESISTENCIA: R3 = Media



| Martillo Schmidt | | | | | | Media |
|---------------------|----|-----|-----|-----|-----|-----------|
| Juntas | 95 | 105 | 100 | 95 | 104 | 100 |
| | 98 | 99 | 104 | 111 | 98 | 68 |
| JCS (Kg/cm2) | | | | | | 98 |

| | | |
|------------------|---------------------|----|
| Fracturas/metro | λ | 9 |
| Juntas/m3 | Jv | 8 |
| Ensayo Tilt-test | φ _{básico} | 30 |

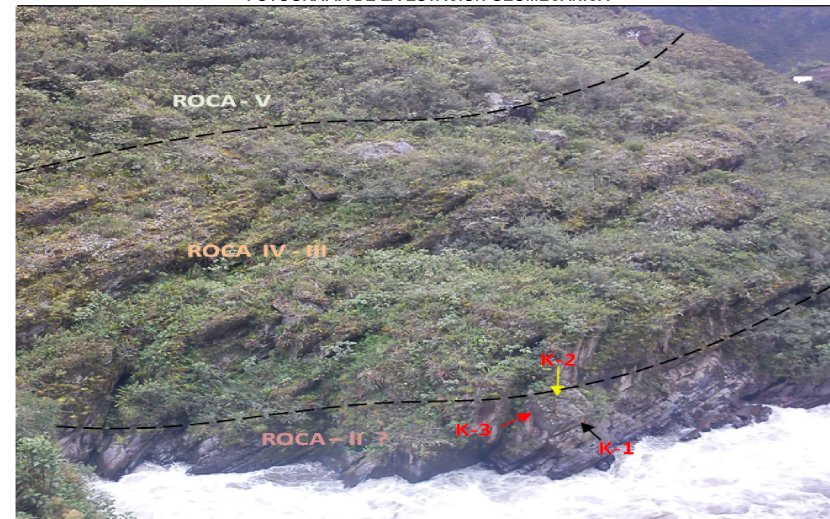
CARACTERIZACIÓN DEL MACIZO ROCOSO - RMR (Bieniawski 1989)

| OBTENCIÓN RMR BÁSICO | | VALORACIÓN MÍNIMA | | VALORACIÓN MÁXIMA | | |
|----------------------|-----------------------------------|------------------------|------------------------|--------------------------|-----------------------|---|
| | | DATOS | VAL. | DATOS | VAL. | |
| RMR 1 | Resistencia a compr. simple (MPa) | Grado IV | 7 | Grado IV | 7 | |
| RMR 2 | Martillo de geólogo | 9 | | 7 | | |
| RMR 2 | Fracturas/metro lineal (λ) | 77 | 15 | 84 | 17 | |
| RMR 2 | RQD | 200 | 8 | 800 | 13 | |
| RMR 4 | Estado de las juntas | Persistencia | 1-3 m | 4 | < 1 m | 6 |
| | | Apertura | 1-5 mm | 1 | 0.1-1.0 mm | 4 |
| | | Rugosidad | Suave | 1 | Rugosa | 5 |
| | | Relleño | Relleño blando < 5 mm | 2 | Relleño blando < 5 mm | 2 |
| | | Alteración | Moderadamente alterado | 3 | Ligeramente alterado | 5 |
| | Suma | | 11 | | 22 | |
| RMR 5 | Presencia de agua | Estado Ligeram. húmedo | 10 | Estado Seco | 15 | |
| | Total | | 51 | Total | 74 | |
| | | | | RMR Básico | 51 a 74 | |
| RMR 6 | F.C. Orientación Túnel | Paralelo/Buz 58 | 12 | Perpend/en contra/Buz 75 | 5 | |
| | | | | RMR Total | 39 a 69 | |

CARACTERIZACIÓN DEL MACIZO ROCOSO - Q (Barton 2002)

| | | | | | | | | | | | |
|--------|------|---|------|----------|------------|----------|------------|--------|------|---|------|
| RQD | 77 | - | 84 | Jr | 2 | - | 3 | Jw | 0.66 | - | 1.00 |
| Jn | 12 | - | 12 | Ja | 3 | - | 2 | SRF | 2.5 | - | 2.50 |
| RQD/Jn | 6.44 | - | 7.03 | Jr/Ja | 0.5 | - | 1.5 | Jw/SRF | 0.26 | - | 0.4 |
| | | | | Q | 0.8 | a | 4.2 | | | | |

FOTOGRAFIA DE LA ESTACIÓN GEOMECÁNICA



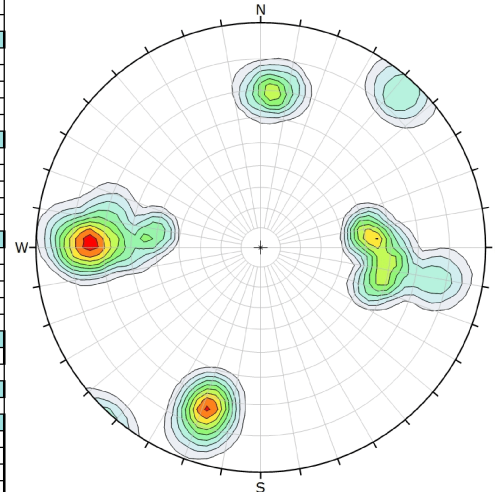
FICHA DE ESTACIÓN GEOMECÁNICA 03

COORDENADAS: X: 340827.837 Y: 8477192.851 Z: 2535.000
 FECHA: dic-15 Calidad de afloramiento: Buena

ESTACIÓN N°: 3

| MEDIDAS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Tipo de Plano | E1 | J1 | J2 | J3 | J4 | J5 | E2 | J6 | J7 | J8 | J9 | J10 | E3 | J11 | J12 | J13 | J14 | J15 | J16 |
| Azimut | 98 | 95 | 87 | 95 | 90 | 90 | 283 | 275 | 274 | 280 | 280 | 265 | 180 | 200 | 186 | 015 | 020 | 020 | 093 |
| Buzamiento | 51 | 66 | 77 | 78 | 70 | 60 | 63 | 51 | 61 | 77 | 55 | 50 | 68 | 73 | 72 | 75 | 68 | 78 | 085 |
| ESPACIADO | | | | | | | | | | | | | | | | | | | |
| > 2000 mm | | | | | | | | | | | | | | | | | | | |
| 600 - 2000 mm | | | X | X | | | | | X | X | | | | | | | | | |
| 200 - 600 mm | X | X | | | X | X | X | X | | | X | X | X | X | X | X | X | X | X |
| 60 - 200 mm | | | | | | | | | | | | | | | | | | | |
| < 60 mm | | | | | | | | | | | | | | | | | | | |
| CONTINUIDAD | | | | | | | | | | | | | | | | | | | |
| < 1 m | | | | | | | | | X | X | X | | | | | | | | |
| 1-3 m | | | | | | | | X | X | | | | X | X | X | X | X | X | X |
| 3-10 m | X | X | X | X | X | X | | | | | | | | | | | | | |
| 10-20 m | | | | | | | | | | | | | | | | | | | |
| >20 m | | | | | | | | | | | | | | | | | | | |
| APERTURA | | | | | | | | | | | | | | | | | | | |
| Nada | | | | | | | | | | | | | | | | | | | |
| < 0.1 mm | | | | | | | | | | | | | | | | | | | |
| 0.1-1.0 mm | | | | | X | X | X | X | X | X | | | | | | | | | X |
| 1-5 mm | X | X | X | X | | | | | | | | | X | X | X | X | X | X | X |
| > 5 mm | | | | | | | | | | | | | | | | | | | |
| RUGOSIDAD | | | | | | | | | | | | | | | | | | | |
| Ondulación | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |
| JRC | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| METOR. JUNTA | | | | | | | | | | | | | | | | | | | |
| Grado | II | II | II | II | II | II | II | II | II | II | II | II | II | II | II | II | II | II | II |
| AGUA | | | | | | | | | | | | | | | | | | | |
| Seco | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Liq. humedo | | | | | | | | | | | | | | | | | | | |
| Humedo | | | | | | | | | | | | | | | | | | | |
| Goteando | | | | | | | | | | | | | | | | | | | |
| Fluyendo | | | | | | | | | | | | | | | | | | | |
| RELLENO | | | | | | | | | | | | | | | | | | | |
| Naturaleza | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe |
| Espesor mm | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |

LITOLOGIA: Metalimolita - metacuarcita FORMACIÓN:
 METEORIZACION: Grado II RESISTENCIA: R5 = Muy dura



| Color | Density Concentrations |
|-------------|------------------------|
| Red | 0.00 - 1.40 |
| Orange | 1.40 - 2.80 |
| Yellow | 2.80 - 4.20 |
| Light Green | 4.20 - 5.60 |
| Green | 5.60 - 7.00 |
| Dark Green | 7.00 - 8.40 |
| Teal | 8.40 - 9.80 |
| Blue-Teal | 9.80 - 11.20 |
| Blue | 11.20 - 12.60 |
| Light Blue | 12.60 - 14.00 |

Maximum Density: 13.40%
 Contour Data: Pole Vectors
 Contour Distribution: Fisher
 Counting Circle Size: 1.0%

Plot Mode: Pole Vectors
 Vector Count: 90 (90 Entradas)
 Hemisphere: Lower
 Projection: Equal Angle

| Martillo Schmidt | | | | | | Media |
|------------------|----|----|----|----|----|-------|
| Juntas | 80 | 74 | 60 | 79 | 64 | 66 |
| | 84 | 55 | 90 | 81 | 75 | 88 |
| JCS (Mpa) | | | | | | 75 |

| | | |
|------------------|---------------------|----|
| Fracturas/metro | λ | 3 |
| Juntas/m3 | Jv | 2 |
| Ensayo Tilt-test | φ _{básico} | 33 |

CARACTERIZACIÓN DEL MACIZO ROCOSO - RMR (Bieniawski 1989)

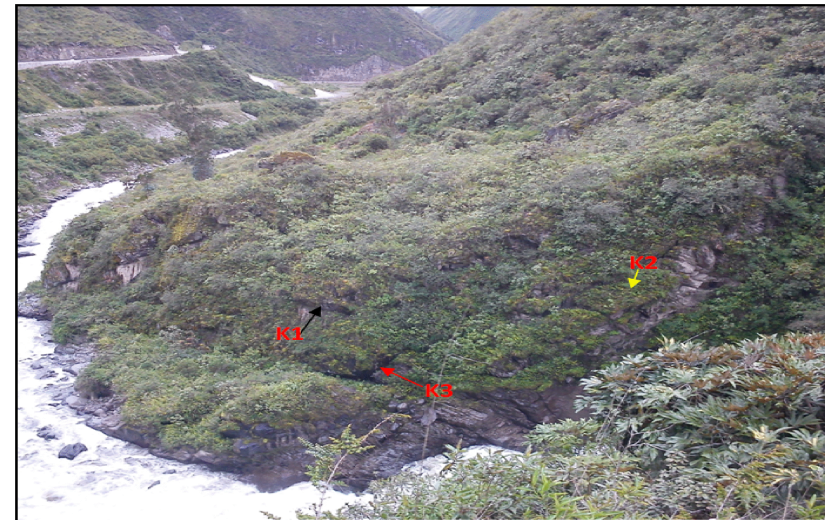
OBTENCIÓN RMR BÁSICO

| | | VALORACIÓN MÍNIMA | | VALORACIÓN MÁXIMA | | |
|-------|-----------------------------------|-------------------|-----------------------|--------------------------|-----------------------|---|
| | | DATOS | VAL. | DATOS | VAL. | |
| RMR 1 | Resistencia a compr. simple (MPa) | | | | | |
| | Martillo de geólogo | Grado V | 12 | Grado V | 12 | |
| RMR 2 | Fracturas/metro lineal (λ) | 3 | 2 | 2 | 2 | |
| | RQD | 96 | 19 | 98 | 20 | |
| RMR 3 | Espaciado (mm) | 300 | 9 | 800 | 13 | |
| RMR 4 | Estado de las juntas | Persistencia | 1-3 m | 4 | < 1 m | 6 |
| | | Apertura | 1-5 mm | 1 | 0.1-1.0 mm | 4 |
| | | Rugosidad | Rugosa | 5 | Rugosa | 5 |
| | | Relleno | Relleno blando < 5 mm | 2 | Relleno blando < 5 mm | 2 |
| | | Alteración | Ligeramente alterado | 5 | Ligeramente alterado | 5 |
| | Suma | | 17 | | 22 | |
| RMR 5 | Presencia de agua | Estado Seco | 15 | Estado Seco | 15 | |
| | | Total | 72 | Total | 82 | |
| | | | | RMR Básico | 72 a 82 | |
| RMR 6 | F.C. Orientación Túnel | Paralelo/Buz 65 | 12 | Perpend/en contra/Buz 75 | 5 | |
| | | | | RMR Total | 60 a 77 | |

CARACTERIZACIÓN DEL MACIZO ROCOSO - Q (Barton 2002)

| | | | | | |
|----------|-------------|-------|-------|--------|--------------------|
| RQD | 96 - 98 | Jr | 3 - 3 | Jw | 1 - 1 |
| Jn | 9 - 9 | Ja | 1 - 1 | SRF | 2.5 - 2.5 |
| RQD/Jn | 10.7 - 10.9 | Jr/Ja | 3 - 3 | Jw/SRF | 0.4 - 0.4 |
| Q | | | | | 12.8 a 13.1 |

FOTOGRAFIA DE LA ESTACIÓN GEOMECÁNICA



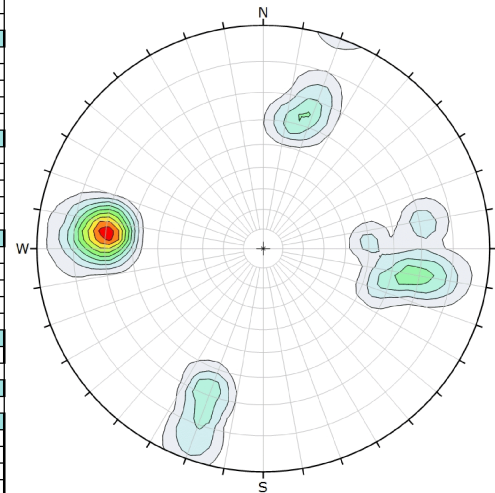
FICHA DE ESTACIÓN GEOMECÁNICA 04

COORDENADAS: X: 340302.807 Y: 8477268.677 Z: 2533.000
 FECHA: dic-15 Calidad de afloramiento: Buena

ESTACIÓN N°: 4

| MEDIDAS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Tipo de Plano | E1 | J1 | J2 | J3 | J4 | J5 | E2 | J6 | J7 | J8 | J9 | J10 | E3 | J11 | J12 | J13 | J14 | J15 | J16 |
| Azimut | 90 | 95 | 98 | 87 | 99 | 97 | 277 | 280 | 282 | 280 | 287 | 265 | 190 | 198 | 200 | 020 | 025 | 020 | 094 |
| Buzamiento | 66 | 68 | 70 | 76 | 67 | 78 | 64 | 68 | 71 | 77 | 55 | 50 | 62 | 75 | 60 | 73 | 65 | 87 | 088 |
| ESPACIADO | | | | | | | | | | | | | | | | | | | |
| > 2000 mm | | | | | | | | | | | | | | | | | | | |
| 600 - 2000 mm | | | | | | | | | | | | | | | | | | | |
| 200 - 600 mm | X | X | X | X | X | X | | | | X | X | X | X | X | X | X | X | X | X |
| 60 - 200 mm | | | | | | | X | X | X | | | | | | | | | | |
| < 60 mm | | | | | | | | | | | | | | | | | | | |
| CONTINUIDAD | | | | | | | | | | | | | | | | | | | |
| < 1 m | | | | | | | X | X | X | X | X | X | | | | | | | |
| 1-3 m | X | X | X | X | X | X | | | | | | | X | X | X | X | X | X | X |
| 3-10 m | | | | | | | | | | | | | | | | | | | |
| 10-20 m | | | | | | | | | | | | | | | | | | | |
| >20 m | | | | | | | | | | | | | | | | | | | |
| APERTURA | | | | | | | | | | | | | | | | | | | |
| Nada | | | | | | | | | | | | | | | | | | | |
| < 0.1 mm | | | | | | | | | | | | | | | | | | | |
| 0.1-1.0 mm | | | | | | | X | X | X | X | X | X | X | X | | | | | |
| 1-5 mm | X | X | X | X | X | X | | | | | | | | | | | | | |
| > 5 mm | | | | | | | | | | | | | | | | | | | |
| RUGOSIDAD | | | | | | | | | | | | | | | | | | | |
| Ondulación | LR | LR | LR | LR | LR | LR | O | O | O | O | O | O | LR | LR | LR | LR | LR | LR | LR |
| JRC | 10 | 10 | 10 | 10 | 10 | 10 | 6 | 6 | 6 | 6 | 6 | 6 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| METOR. JUNTA | | | | | | | | | | | | | | | | | | | |
| Grado | III | III | III | III | III | III | III | III | III | III | III | III | III | III | III | III | III | III | III |
| AGUA | | | | | | | | | | | | | | | | | | | |
| Seco | | | | | | | X | X | X | X | X | X | | | | | | | |
| Liq. humedo | X | X | X | X | X | X | | | | | | | X | X | X | X | X | X | X |
| Humedo | | | | | | | | | | | | | | | | | | | |
| Goteando | | | | | | | | | | | | | | | | | | | |
| Fluyendo | | | | | | | | | | | | | | | | | | | |
| RELLENO | | | | | | | | | | | | | | | | | | | |
| Naturaleza | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe |
| Espesor mm | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |

LITOLOGIA: Metalimolita Gris a Marrón FORMACIÓN:
 METEORIZACION: Grado III RESISTENCIA: R4 = Dura



| Color | Density Concentrations |
|-------|------------------------|
| 0.00 | 0.00 - 2.30 |
| 2.30 | 2.30 - 4.60 |
| 4.60 | 4.60 - 6.90 |
| 6.90 | 6.90 - 9.20 |
| 9.20 | 9.20 - 11.50 |
| 11.50 | 11.50 - 13.80 |
| 13.80 | 13.80 - 16.10 |
| 16.10 | 16.10 - 18.40 |
| 18.40 | 18.40 - 20.70 |
| 20.70 | 20.70 - 23.00 |

Maximum Density 22.27%

Contour Data Pole Vectors

Contour Distribution Fisher

Counting Circle Size 1.0%

Plot Mode Pole Vectors

Vector Count 90 (90 Entries)

Hemisphere Lower

Projection Equil Angle

| Martillo Schmidt | | | | | | Media |
|------------------|----|----|----|----|----|-----------|
| Juntas | 68 | 50 | 45 | 60 | 45 | 35 |
| | 46 | 55 | 80 | 81 | 38 | 75 |
| JCS (Mpa) | | | | | | 60 |

| | | |
|------------------|---------------------|----|
| Fracturas/metro | λ | 5 |
| Juntas/m3 | Jv | 6 |
| Ensayo Tilt-test | φ _{básico} | 30 |

CARACTERIZACIÓN DEL MACIZO ROCOSO - RMR (Bieniawski 1989)

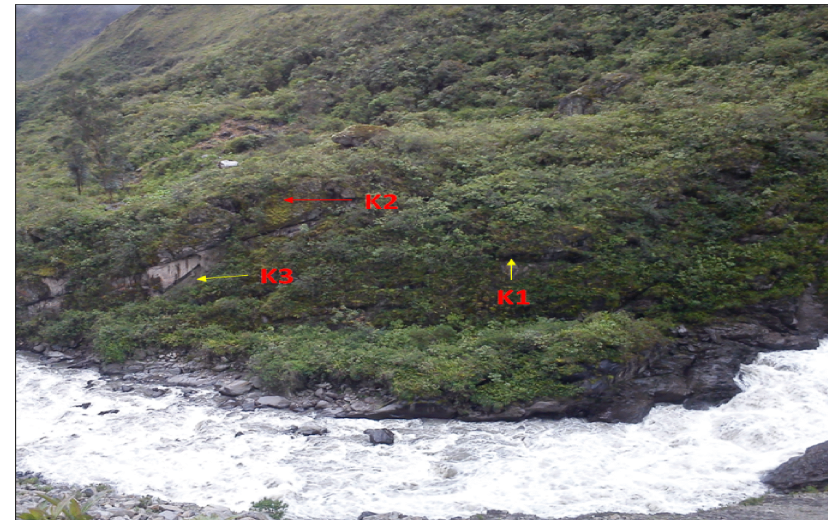
OBTENCIÓN RMR BÁSICO

| | | VALORACIÓN MÍNIMA | | VALORACIÓN MÁXIMA | | |
|-------|-----------------------------------|------------------------|------------------------|--------------------------|-----------------------|---|
| | | DATOS | VAL. | DATOS | VAL. | |
| RMR 1 | Resistencia a compr. simple (MPa) | | | | | |
| | Martillo de geólogo | Grado IV | 7 | Grado IV | 7 | |
| RMR 2 | Fracturas/metro lineal (λ) | 6 | 4 | | | |
| | RQD | 88 | 18 | 94 | 19 | |
| RMR 3 | Espaciado (mm) | 150 | 7 | 600 | 12 | |
| RMR 4 | Estado de las juntas | Persistencia | 1-3 m | 4 | < 1 m | 6 |
| | | Apertura | 1-5 mm | 1 | 0.1-1.0 mm | 4 |
| | | Rugosidad | Suave | 1 | Ligeramente Rugosa | 3 |
| | | Relleño | Relleño blando < 5 mm | 2 | Relleño blando < 5 mm | 2 |
| | | Alteración | Moderadamente alterado | 3 | Ligeramente alterado | 5 |
| | Suma | | 11 | | 20 | |
| RMR 5 | Presencia de agua | Estado Ligeram. húmedo | 10 | Estado Seco | 15 | |
| | Total | | 53 | Total | 73 | |
| | | | | RMR Básico | 53 a 73 | |
| RMR 6 | F.C. Orientación Túnel | Paralelo/Buz 68 | 12 | Perpend/en contra/Buz 70 | 5 | |
| | | | | RMR Total | 41 a 68 | |

CARACTERIZACIÓN DEL MACIZO ROCOSO - Q (Barton 2002)

| | | | | | | | | | | | |
|--------|------|---|------|-------|---|---|-----|----------|------------|----------|------------|
| RQD | 88 | - | 94 | Jr | 2 | - | 3 | Jw | 0.66 | - | 0.66 |
| Jn | 12 | - | 12 | Ja | 2 | - | 2 | SRF | 2.5 | - | 2.5 |
| RQD/Jn | 7.32 | - | 7.82 | Jr/Ja | 1 | - | 1.5 | Jw/SRF | 0.26 | - | 0.26 |
| | | | | | | | | Q | 1.9 | a | 3.1 |

FOTOGRAFIA DE LA ESTACIÓN GEOMECÁNICA

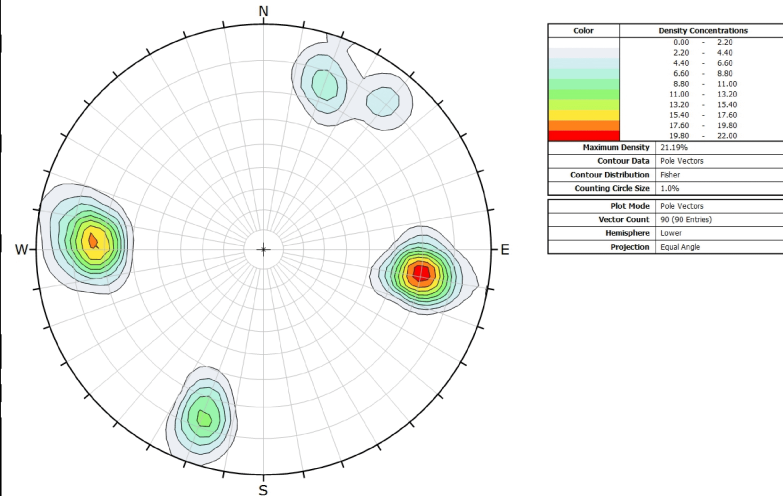


FICHA DE ESTACIÓN GEOMECÁNICA 05

COORDENADAS: X: 340321.299 Y: 8477347.349 Z: 2525.000 ESTACIÓN Nº: 5
 FECHA: dic-15 Calidad de afloramiento: Buena

| MEDIDAS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Tipo de Plano | E1 | J1 | J2 | J3 | J4 | J5 | E2 | J6 | J7 | J8 | J9 | J10 | E3 | J11 | J12 | J13 | J14 | J15 | J16 |
| Azimut | 95 | 87 | 98 | 84 | 100 | 90 | 278 | 271 | 280 | 281 | 284 | 281 | 219 | 196 | 205 | 020 | 025 | 017 | 092 |
| Buzamiento | 72 | 77 | 70 | 71 | 84 | 70 | 66 | 71 | 68 | 72 | 68 | 77 | 81 | 78 | 73 | 77 | 68 | 80 | 073 |
| ESPACIADO | | | | | | | | | | | | | | | | | | | |
| > 2000 mm | | | | | | | | | | | | | | | | | | | |
| 600 - 2000 mm | | | | | | | | | | X | X | X | | | | | X | X | X |
| 200 - 600 mm | | | | X | X | X | X | X | X | | | | | | X | | | | |
| 60 - 200 mm | X | X | X | | | | | | | | | | | X | X | X | | | |
| < 60 mm | | | | | | | | | | | | | | | | | | | |
| CONTINUIDAD | | | | | | | | | | | | | | | | | | | |
| < 1 m | | | | | | | X | X | X | X | X | X | | | | | | | |
| 1-3 m | X | X | X | X | X | X | | | | | | | X | X | X | X | X | X | X |
| 3-10 m | | | | | | | | | | | | | | | | | | | |
| 10-20 m | | | | | | | | | | | | | | | | | | | |
| >20 m | | | | | | | | | | | | | | | | | | | |
| APERTURA | | | | | | | | | | | | | | | | | | | |
| Nada | | | | | | | | | | | | | | | | | | | |
| < 0.1 mm | | | | | | | | | | | | | | | | | | | |
| 0.1-1.0 mm | | | | | | | | | | | | | | | | | | | |
| 1-5 mm | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| > 5 mm | | | | | | | | | | | | | | | | | | | |
| RUGOSIDAD | | | | | | | | | | | | | | | | | | | |
| Ondulación | LR | LR | LR | LR | LR | LR | S | S | S | S | S | S | S | S | S | S | S | S | S |
| JRC | 10 | 10 | 10 | 10 | 10 | 10 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| METOR. JUNTA | | | | | | | | | | | | | | | | | | | |
| Grado | IV | IV | IV | IV | IV | IV | IV | IV | IV | IV | IV | IV | IV | IV | IV | IV | IV | IV | IV |
| AGUA | | | | | | | | | | | | | | | | | | | |
| Seco | | | | | | | | | | | | | | | | | | | |
| Liq. humedo | | | | | | | | | | | | | | X | X | X | X | X | X |
| Humedo | | | | | | | X | X | X | X | X | | | | | | | | |
| Goteando | X | X | X | X | X | X | | | | | | | | | | | | | |
| Fluyendo | | | | | | | | | | | | | | | | | | | |
| RELLENO | | | | | | | | | | | | | | | | | | | |
| Naturaleza | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe |
| Espesor mm | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |

LITOLOGIA: Metalimolita - metacarcita FORMACIÓN:
 METEORIZACION: Grado IV RESISTENCIA: R4 = Dura



| Martillo Schmidt | | | | | | Media |
|------------------|----|----|----|----|----|-----------|
| Juntas | 74 | 59 | 48 | 59 | 58 | 45 |
| | 39 | 66 | 84 | 81 | 64 | 54 |
| JCS (Mpa) | | | | | | 65 |

| | | |
|------------------|---------------------|----|
| Fracturas/metro | λ | 12 |
| Juntas/m3 | Jv | 13 |
| Ensayo Tilt-test | φ _{básico} | 37 |

CARACTERIZACIÓN DEL MACIZO ROCOSO - RMR (Bieniawski 1989)

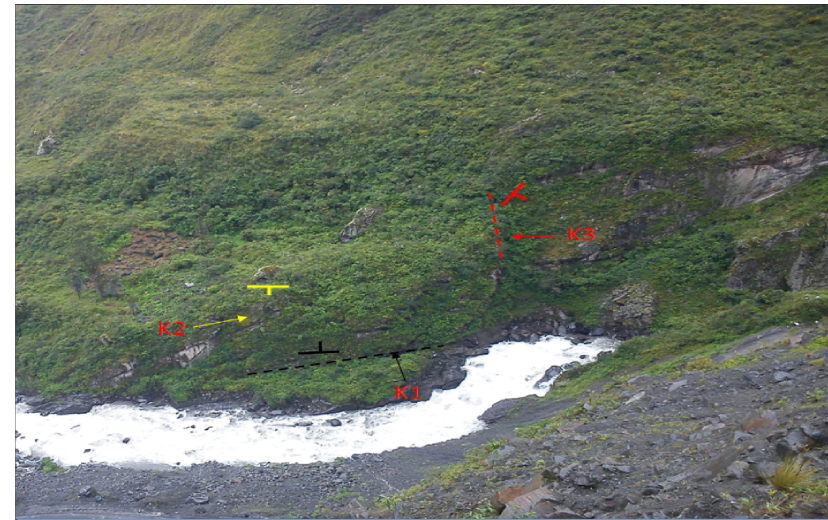
OBTENCIÓN RMR BÁSICO

| | | VALORACIÓN MÍNIMA | | VALORACIÓN MÁXIMA | | |
|-------|-----------------------------------|-------------------|------------------------|---------------------------|------------------------|---|
| | | DATOS | VAL. | DATOS | VAL. | |
| RMR 1 | Resistencia a compr. simple (MPa) | | | | | |
| | Martillo de geólogo | Grado IV | 7 | Grado IV | 7 | |
| RMR 2 | Fracturas/metro lineal (λ) | 13 | 11 | | | |
| | RQD | 63 | 12 | 70 | 14 | |
| RMR 3 | Espaciado (mm) | 100 | 7 | 800 | 13 | |
| RMR 4 | Estado de las juntas | Persistencia | 1-3 m | 4 | < 1 m | 6 |
| | | Apertura | 1-5 mm | 1 | 1-5 mm | 1 |
| | | Rugosidad | Suave | 1 | Ligeramente Rugosa | 3 |
| | | Relleno | Relleno blando < 5 mm | 2 | Relleno blando < 5 mm | 2 |
| | | Alteración | Moderadamente alterado | 3 | Moderadamente alterado | 3 |
| | Suma | | 11 | | 15 | |
| RMR 5 | Presencia de agua | Estado Goteando | 4 | Estado Ligeram. húmedo | 10 | |
| | Total | | 41 | Total | 59 | |
| | | RMR Básico | 41 | a | 59 | |
| RMR 6 | F.C. Orientación Túnel | Paralelo/Buz 73 | 12 | Perpend/Con el buz/Buz 76 | 0 | |
| | | RMR Total | 29 | a | 59 | |

CARACTERIZACIÓN DEL MACIZO ROCOSO - Q (Barton 2002)

| | | | | | | | | | | | |
|--------|------|----------|------------|----------|------------|---|-----|--------|------|---|-----|
| RQD | 63 | - | 70 | Jr | 2 | - | 3 | Jw | 0.66 | - | 1 |
| Jn | 12 | - | 9 | Ja | 2 | - | 2 | SRF | 2.5 | - | 2.5 |
| RQD/Jn | 5.22 | - | 7.77 | Jr/Ja | 1 | - | 1.5 | Jw/SRF | 0.26 | - | 0.4 |
| | | Q | 1.4 | a | 4.7 | | | | | | |

FOTOGRAFIA DE LA ESTACIÓN GEOMECÁNICA

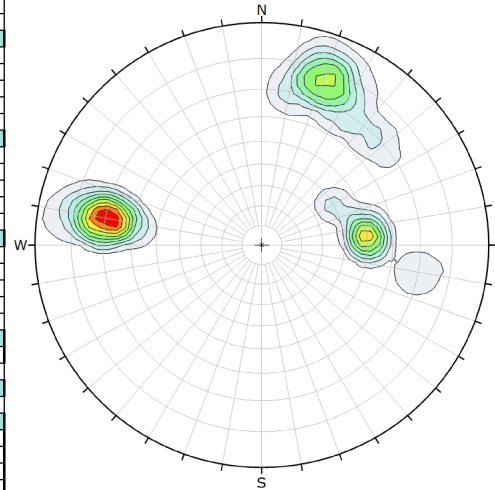


FICHA DE ESTACIÓN GEOMECÁNICA 06

COORDENADAS: X: 340160.700 Y: 8476743.000 Z: 2577.000 ESTACIÓN Nº: 6
 FECHA: dic-15 Calidad de afloramiento: Buena

| MEDIDAS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Tipo de Plano | E1 | J1 | J2 | J3 | J4 | J5 | E2 | J6 | J7 | J8 | J9 | J10 | E3 | J11 | J12 | J13 | J14 | J15 | J16 |
| Azímüt | 95 | 101 | 98 | 103 | 103 | 100 | 240 | 271 | 270 | 280 | 280 | 263 | 200 | 196 | 205 | 190 | 225 | 210 | 100 |
| Buzamiento | 55 | 65 | 70 | 66 | 80 | 74 | 40 | 50 | 52 | 67 | 45 | 52 | 75 | 78 | 76 | 65 | 68 | 70 | 063 |
| ESPACIADO | | | | | | | | | | | | | | | | | | | |
| > 2000 mm | | | | | | | | | | | | | | | | | | | |
| 600 - 2000 mm | | | | | | X | | | | | X | X | X | | | | | X | X |
| 200 - 600 mm | | | | X | X | | X | X | X | | | | | | | X | | | |
| 60 - 200 mm | X | X | X | | | | | | | | | | | X | X | X | | | |
| < 60 mm | | | | | | | | | | | | | | | | | | | |
| CONTINUIDAD | | | | | | | | | | | | | | | | | | | |
| < 1 m | | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 1-3 m | X | X | X | X | X | X | | | | | | | | | | | | | |
| 3-10 m | | | | | | | | | | | | | | | | | | | |
| 10-20 m | | | | | | | | | | | | | | | | | | | |
| >20 m | | | | | | | | | | | | | | | | | | | |
| APERTURA | | | | | | | | | | | | | | | | | | | |
| Nada | | | | | | | | | | | | | | | | | | | |
| < 0.1 mm | | | | | | | | | | | | | | | | | | | |
| 0.1-1.0 mm | X | X | X | X | X | X | | | | | | | | | | | | | |
| 1-5 mm | | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| > 5 mm | | | | | | | | | | | | | | | | | | | |
| RUGOSIDAD | | | | | | | | | | | | | | | | | | | |
| Ondulación | LR | LR | LR | LR | LR | LR | LR | LR | LR | LR | LR | LR | LR | LR | LR | LR | LR | LR | LR |
| JRC | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| METOR. JUNTA | | | | | | | | | | | | | | | | | | | |
| Grado | III | III | III | III | III | III | II | II | II | II | II | II | II | II | II | II | II | II | II |
| AGUA | | | | | | | | | | | | | | | | | | | |
| Seco | X | X | X | X | X | X | X | X | X | X | X | X | | | | | | | |
| Liq. humedo | | | | | | | | | | | | | X | X | X | X | X | X | X |
| Humedo | | | | | | | | | | | | | | | | | | | |
| Goteando | | | | | | | | | | | | | | | | | | | |
| Fluyendo | | | | | | | | | | | | | | | | | | | |
| RELLENO | | | | | | | | | | | | | | | | | | | |
| Naturaleza | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe |
| Espesor mm | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |

LITOLOGIA: Metalimolita - metacuarcita FORMACIÓN:
 METEORIZACION: Grado III RESISTENCIA: R4 = Dura



| Color | Density Concentrations |
|-------|------------------------|
| 0.00 | - 2.30 |
| 2.30 | - 4.60 |
| 4.60 | - 6.90 |
| 6.90 | - 9.20 |
| 9.20 | - 11.50 |
| 11.50 | - 13.80 |
| 13.80 | - 16.10 |
| 16.10 | - 18.40 |
| 18.40 | - 20.70 |
| 20.70 | - 23.00 |

Maximum Density 22.48%
 Contour Data Pole Vectors
 Contour Distribution Fisher
 Counting Circle Size 1.0%

Plot Mode Pole Vectors
 Vector Count 90 (No Entries)
 Hemisphere Lower
 Projection Equal Angle

| | Martillo Schmidt | | | | | | | Media |
|--------|------------------|----|----|----|----|----|--|-------|
| Juntas | 48 | 55 | 39 | 64 | 85 | 69 | | 69.20 |
| | 49 | 80 | 84 | 81 | 87 | 69 | | |
| | JCS (Mpa) | | | | | | | 70 |

| | | |
|------------------|---------------------|----|
| Fracturas/metro | λ | 7 |
| Juntas/m3 | Jv | 7 |
| Ensayo Tilt-test | φ _{básico} | 34 |

CARACTERIZACIÓN DEL MACIZO ROCOSO - RMR (Bieniawski 1989)

| OBTENCIÓN RMR BÁSICO | | VALORACIÓN MÍNIMA | | VALORACIÓN MÁXIMA | | |
|----------------------|-----------------------------------|------------------------|------------------------|---------------------------|-----------------------|---|
| | | DATOS | VAL. | DATOS | VAL. | |
| RMR 1 | Resistencia a compr. simple (MPa) | | | | | |
| | Martillo de geólogo | Grado IV | 7 | Grado IV | 7 | |
| RMR 2 | Fracturas/metro lineal (λ) | 8 | | 6 | | |
| | RQD | 81 | 16 | 88 | 18 | |
| RMR 3 | Espaciado (mm) | 100 | 7 | 900 | 14 | |
| RMR 4 | Estado de las juntas | Persistencia | 1-3 m | 4 | < 1 m | 6 |
| | | Apertura | 1-5 mm | 1 | 0.1-1.0 mm | 4 |
| | | Rugosidad | Ligeramente Rugosa | 3 | Ligeramente Rugosa | 3 |
| | | Relleno | Relleno blando < 5 mm | 2 | Relleno blando < 5 mm | 2 |
| | | Alteración | Moderadamente alterado | 3 | Ligeramente alterado | 5 |
| | Suma | | 13 | | 20 | |
| RMR 5 | Presencia de agua | Estado Ligeram. húmedo | 10 | Estado Seco | 15 | |
| | Total | | 53 | Total | 74 | |
| | | | | RMR Básico | 53 a 74 | |
| RMR 6 | F.C. Orientación Túnel | Paralelo/Buz 72 | 12 | Perpend/con el buz/Buz 51 | 0 | |
| | | | | RMR Total | 41 a 74 | |

CARACTERIZACIÓN DEL MACIZO ROCOSO - Q (Barton 2002)

| | | | | | |
|--------|-------------|-------|-------|--------|-----------|
| RQD | 81 - 88 | Jr | 2 - 2 | Jw | 1 - 1 |
| Jn | 12 - 9 | Ja | 2 - 1 | SRF | 2.5 - 2.5 |
| RQD/Jn | 6.74 - 9.76 | Jr/Ja | 1 - 2 | Jw/SRF | 0.4 - 0.4 |
| | | | | Q | 2.7 a 7.8 |

FOTOGRAFIA DE LA ESTACIÓN GEOMECÁNICA



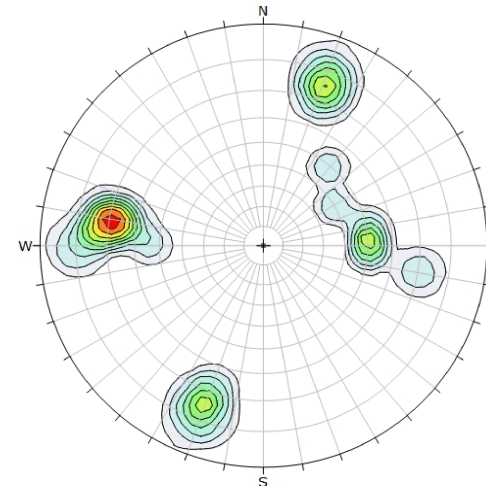
FICHA DE ESTACIÓN GEOMECÁNICA 07

COORDENADAS: X: 340502.500 Y: 8477577.000 Z: 2517.000
 FECHA: dic-15 Calidad de afloramiento: Buena

ESTACIÓN Nº: 7

| MEDIDAS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Tipo de Plano | E1 | J1 | J2 | J3 | J4 | J5 | E2 | J6 | J7 | J8 | J9 | J10 | E3 | J11 | J12 | J13 | J14 | J15 | J16 |
| Azimut | 95 | 101 | 98 | 100 | 87 | 98 | 240 | 271 | 270 | 280 | 215 | 263 | 200 | 196 | 205 | 025 | 019 | 020 | 097 |
| Buzamiento | 55 | 65 | 70 | 72 | 78 | 70 | 40 | 50 | 52 | 70 | 49 | 50 | 75 | 78 | 76 | 75 | 78 | 68 | 063 |
| ESPACIADO | | | | | | | | | | | | | | | | | | | |
| > 2000 mm | | | | | | | | | | | | | | | | | | | |
| 600 - 2000 mm | | | | | | | | | | | | X | | | | | | | |
| 200 - 600 mm | | | | X | X | X | | | | | X | X | | | | X | X | X | X |
| 60 - 200 mm | X | X | X | | | | X | X | X | X | | | X | X | X | | | | |
| < 60 mm | | | | | | | | | | | | | | | | | | | |
| CONTINUIDAD | | | | | | | | | | | | | | | | | | | |
| < 1 m | | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| 1-3 m | X | X | X | X | X | X | | | | | | | | | | | | | |
| 3-10 m | | | | | | | | | | | | | | | | | | | |
| 10-20 m | | | | | | | | | | | | | | | | | | | |
| >20 m | | | | | | | | | | | | | | | | | | | |
| APERTURA | | | | | | | | | | | | | | | | | | | |
| Nada | | | | | | | | | | | | | | | | | | | |
| < 0.1 mm | | | | | | | | | | | | | | | | | | | |
| 0.1-1.0 mm | | | | | | | | | | | | | | | | | | | |
| 1-5 mm | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| > 5 mm | | | | | | | | | | | | | | | | | | | |
| RUGOSIDAD | | | | | | | | | | | | | | | | | | | |
| Ondulación | R | R | R | R | R | R | LR | LR | LR | LR | LR | LR | LR | LR | LR | LR | LR | LR | LR |
| JRC | 14 | 14 | 14 | 14 | 14 | 14 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| METOR. JUNTA | | | | | | | | | | | | | | | | | | | |
| Grado | III | III | III | III | III | III | III | III | III | III | III | III | III | III | III | III | III | III | III |
| AGUA | | | | | | | | | | | | | | | | | | | |
| Seco | | | | | | | | | | | | | | | | | | | |
| Liq. humedo | X | X | X | X | X | X | | | | | | | | | | | | | |
| Humedo | | | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Goteando | | | | | | | | | | | | | | | | | | | |
| Fluyendo | | | | | | | | | | | | | | | | | | | |
| RELLENO | | | | | | | | | | | | | | | | | | | |
| Naturaleza | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe | ox-Fe |
| Espesor mm | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 |

LITOLOGIA: Metalimolita - metacuarcita FORMACIÓN:
 METEORIZACION: Grado III RESISTENCIA: R4 = Dura



| Color | Density Concentrations |
|-------|------------------------|
| 0.00 | 1.50 |
| 1.50 | 2.00 |
| 2.00 | 2.50 |
| 2.50 | 3.00 |
| 3.00 | 3.50 |
| 3.50 | 4.00 |
| 4.00 | 4.50 |
| 4.50 | 5.00 |
| 5.00 | 5.50 |
| 5.50 | 6.00 |
| 6.00 | 6.50 |
| 6.50 | 7.00 |
| 7.00 | 7.50 |
| 7.50 | 8.00 |
| 8.00 | 8.50 |
| 8.50 | 9.00 |
| 9.00 | 9.50 |
| 9.50 | 10.00 |
| 10.00 | 10.50 |
| 10.50 | 11.00 |
| 11.00 | 11.50 |
| 11.50 | 12.00 |
| 12.00 | 12.50 |
| 12.50 | 13.00 |
| 13.00 | 13.50 |
| 13.50 | 14.00 |
| 14.00 | 14.50 |
| 14.50 | 15.00 |
| 15.00 | 15.50 |
| 15.50 | 16.00 |
| 16.00 | 16.50 |
| 16.50 | 17.00 |
| 17.00 | 17.50 |
| 17.50 | 18.00 |
| 18.00 | 18.50 |
| 18.50 | 19.00 |
| 19.00 | 19.50 |
| 19.50 | 20.00 |
| 20.00 | 20.50 |
| 20.50 | 21.00 |
| 21.00 | 21.50 |
| 21.50 | 22.00 |
| 22.00 | 22.50 |
| 22.50 | 23.00 |
| 23.00 | 23.50 |
| 23.50 | 24.00 |
| 24.00 | 24.50 |
| 24.50 | 25.00 |
| 25.00 | 25.50 |
| 25.50 | 26.00 |
| 26.00 | 26.50 |
| 26.50 | 27.00 |
| 27.00 | 27.50 |
| 27.50 | 28.00 |
| 28.00 | 28.50 |
| 28.50 | 29.00 |
| 29.00 | 29.50 |
| 29.50 | 30.00 |
| 30.00 | 30.50 |
| 30.50 | 31.00 |
| 31.00 | 31.50 |
| 31.50 | 32.00 |
| 32.00 | 32.50 |
| 32.50 | 33.00 |
| 33.00 | 33.50 |
| 33.50 | 34.00 |
| 34.00 | 34.50 |
| 34.50 | 35.00 |
| 35.00 | 35.50 |
| 35.50 | 36.00 |
| 36.00 | 36.50 |
| 36.50 | 37.00 |
| 37.00 | 37.50 |
| 37.50 | 38.00 |
| 38.00 | 38.50 |
| 38.50 | 39.00 |
| 39.00 | 39.50 |
| 39.50 | 40.00 |
| 40.00 | 40.50 |
| 40.50 | 41.00 |
| 41.00 | 41.50 |
| 41.50 | 42.00 |
| 42.00 | 42.50 |
| 42.50 | 43.00 |
| 43.00 | 43.50 |
| 43.50 | 44.00 |
| 44.00 | 44.50 |
| 44.50 | 45.00 |
| 45.00 | 45.50 |
| 45.50 | 46.00 |
| 46.00 | 46.50 |
| 46.50 | 47.00 |
| 47.00 | 47.50 |
| 47.50 | 48.00 |
| 48.00 | 48.50 |
| 48.50 | 49.00 |
| 49.00 | 49.50 |
| 49.50 | 50.00 |
| 50.00 | 50.50 |
| 50.50 | 51.00 |
| 51.00 | 51.50 |
| 51.50 | 52.00 |
| 52.00 | 52.50 |
| 52.50 | 53.00 |
| 53.00 | 53.50 |
| 53.50 | 54.00 |
| 54.00 | 54.50 |
| 54.50 | 55.00 |
| 55.00 | 55.50 |
| 55.50 | 56.00 |
| 56.00 | 56.50 |
| 56.50 | 57.00 |
| 57.00 | 57.50 |
| 57.50 | 58.00 |
| 58.00 | 58.50 |
| 58.50 | 59.00 |
| 59.00 | 59.50 |
| 59.50 | 60.00 |
| 60.00 | 60.50 |
| 60.50 | 61.00 |
| 61.00 | 61.50 |
| 61.50 | 62.00 |
| 62.00 | 62.50 |
| 62.50 | 63.00 |
| 63.00 | 63.50 |
| 63.50 | 64.00 |
| 64.00 | 64.50 |
| 64.50 | 65.00 |
| 65.00 | 65.50 |
| 65.50 | 66.00 |
| 66.00 | 66.50 |
| 66.50 | 67.00 |
| 67.00 | 67.50 |
| 67.50 | 68.00 |
| 68.00 | 68.50 |
| 68.50 | 69.00 |
| 69.00 | 69.50 |
| 69.50 | 70.00 |
| 70.00 | 70.50 |
| 70.50 | 71.00 |
| 71.00 | 71.50 |
| 71.50 | 72.00 |
| 72.00 | 72.50 |
| 72.50 | 73.00 |
| 73.00 | 73.50 |
| 73.50 | 74.00 |
| 74.00 | 74.50 |
| 74.50 | 75.00 |
| 75.00 | 75.50 |
| 75.50 | 76.00 |
| 76.00 | 76.50 |
| 76.50 | 77.00 |
| 77.00 | 77.50 |
| 77.50 | 78.00 |
| 78.00 | 78.50 |
| 78.50 | 79.00 |
| 79.00 | 79.50 |
| 79.50 | 80.00 |
| 80.00 | 80.50 |
| 80.50 | 81.00 |
| 81.00 | 81.50 |
| 81.50 | 82.00 |
| 82.00 | 82.50 |
| 82.50 | 83.00 |
| 83.00 | 83.50 |
| 83.50 | 84.00 |
| 84.00 | 84.50 |
| 84.50 | 85.00 |
| 85.00 | 85.50 |
| 85.50 | 86.00 |
| 86.00 | 86.50 |
| 86.50 | 87.00 |
| 87.00 | 87.50 |
| 87.50 | 88.00 |
| 88.00 | 88.50 |
| 88.50 | 89.00 |
| 89.00 | 89.50 |
| 89.50 | 90.00 |
| 90.00 | 90.50 |
| 90.50 | 91.00 |
| 91.00 | 91.50 |
| 91.50 | 92.00 |
| 92.00 | 92.50 |
| 92.50 | 93.00 |
| 93.00 | 93.50 |
| 93.50 | 94.00 |
| 94.00 | 94.50 |
| 94.50 | 95.00 |
| 95.00 | 95.50 |
| 95.50 | 96.00 |
| 96.00 | 96.50 |
| 96.50 | 97.00 |
| 97.00 | 97.50 |
| 97.50 | 98.00 |
| 98.00 | 98.50 |
| 98.50 | 99.00 |
| 99.00 | 99.50 |
| 99.50 | 100.00 |

| Martillo Schmidt | | | | | | | Media |
|------------------|----|----|----|----|----|----|-------|
| Juntas | 84 | 88 | 81 | 59 | 64 | 74 | 74.10 |
| | 68 | 67 | 72 | 75 | 73 | 78 | |
| JCS (Mpa) | | | | | | | 75 |

| | | |
|------------------|---------------------|----|
| Fracturas/metro | λ | 9 |
| Juntas/m3 | Jv | 7 |
| Ensayo Tilt-test | φ _{básico} | 32 |

CARACTERIZACIÓN DEL MACIZO ROCOSO - RMR (Bieniawski 1989)

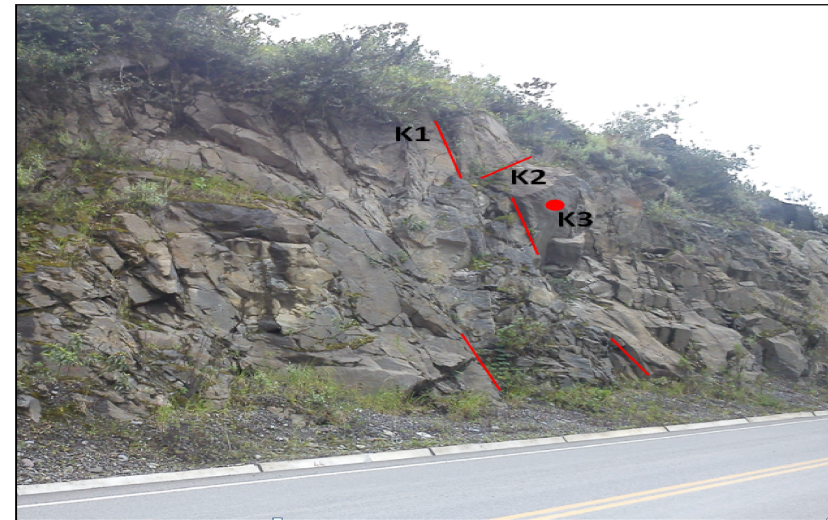
OBTENCIÓN RMR BÁSICO

| RMR | DESCRIPCIÓN | VALORACIÓN MÍNIMA | | VALORACIÓN MÁXIMA | | |
|-------|-----------------------------------|-------------------|------------------------|---------------------------|------------------------|---|
| | | DATOS | VAL. | DATOS | VAL. | |
| RMR 1 | Resistencia a compr. simple (MPa) | | | | | |
| | Martillo de geólogo | Grado IV | 7 | Grado IV | 7 | |
| RMR 2 | Fracturas/metro lineal (λ) | 10 | 7 | 7 | 7 | |
| | RQD | 74 | 15 | 84 | 17 | |
| RMR 3 | Espaciado (mm) | 100 | 7 | 600 | 12 | |
| RMR 4 | Estado de las juntas | Persistencia | 1-3 m | 4 | < 1 m | 6 |
| | | Apertura | 1-5 mm | 1 | 1-5 mm | 1 |
| | | Rugosidad | Ligeramente Rugosa | 3 | Rugosa | 5 |
| | | Relleno | Relleno blando < 5 mm | 2 | Relleno blando < 5 mm | 2 |
| | | Alteración | Moderadamente alterado | 3 | Moderadamente alterado | 3 |
| | Suma | | 13 | | 17 | |
| RMR 5 | Presencia de agua | Estado Húmedo | 7 | Estado Ligeram. húmedo | 10 | |
| | Total | | 49 | Total | 63 | |
| | | | | RMR Básico | 49 a 63 | |
| RMR 6 | F.C. Orientación Túnel | Paralelo/Buz 75 | 12 | Perpend/con el buz/Buz 63 | 0 | |
| | | | | RMR Total | 37 a 63 | |

CARACTERIZACIÓN DEL MACIZO ROCOSO - Q (Barton 2002)

| | | | | | | | | | | | |
|--------|------|---|------|-------|---|---|-----|----------|------------------|---|-----|
| RQD | 74 | - | 84 | Jr | 2 | - | 3 | Jw | 1 | - | 1 |
| Jn | 12 | - | 12 | Ja | 2 | - | 2 | SRF | 2.5 | - | 2.5 |
| RQD/Jn | 6.13 | - | 7.03 | Jr/Ja | 1 | - | 1.5 | Jw/SRF | 0.4 | - | 0.4 |
| | | | | | | | | Q | 2.5 a 4.2 | | |

FOTOGRAFIA DE LA ESTACIÓN GEOMECÁNICA



FICHA DE ESTACIÓN GEOTÉCNICA 01

COORDENADAS: X: 340261.240 Y: 8476938.230 Z: 2539.000 ESTACIÓN N°: S-1
 FECHA: dic-15 Calidad de afloramiento: Buena

| Profundidad | Desde | | 0 m | |
|--|-------------------------------|--------------------------------------|-------|--|
| | Hasta | | 2m | |
| Granulometría estimada | Total (Volumen) | T. Max (pulg) >50 | 0.50 | |
| | | Clastos % > 12 | 1.50 | |
| | | Bolones (%>3" <12") | 2.00 | |
| | Fracción bajo tamiz 3" (Peso) | Resto (>3") | 5.00 | |
| | | Grava (%) | 44.30 | |
| | | Arena (%) | 21.60 | |
| | Fino (%) | 24.40 | | |
| Color en Estado Natural / Olor | | Gris | | |
| Graduación / Dilatación | | Mala | | |
| Tipo de granos | | Grava, arena, limo y bloques | | |
| Forma de partículas | | sun angulosos | | |
| Dureza de partículas | | R4 | | |
| Angularidad de Partículas / Resistencia seca | | 60° - 90° | | |
| Humedad | | 10 | | |
| Plasticidad | | NP | | |
| Consistencia o Compacidad | | Moderadamente denso | | |
| Estructura | | Posible contacto con roca fracturada | | |
| Cementación | | Nula | | |
| Reacción al HCL | | Sin Reacción | | |
| Materia Orgánica o raíces | | > 0.20 m | | |
| Origen Geológico | | Fluvio Glaciar | | |
| Resistencia a la Excavación | | media | | |
| AASHTO | | A-2-4(0) | | |
| Símbolo del Grupo USCS | | GC | | |
| Nombre local del Suelo | | Laderas de pie de monte | | |

| Índice de Meteorización (WI) | | |
|-----------------------------------|-----|-------------|
| W3 | | |
| Moderadamente meteorizado | | |
| Índice de Dureza (SI) | | |
| Bloques | R4 | Roca dura |
| Matriz | R-2 | Suelo débil |
| Condición de Agua (GW) | | |
| 7 | | |
| Húmedo | | |
| Índice de Resist. Geológica (GSI) | | |
| 20 | | |

Tipo y Descripción del suelo:
 Material de origen fluvio glaciar, compuesto de bloques sub angulosos (diámetro 0,1 - 3.0 m) de roca metalimolita y metacuarcitas, inmersa en matriz arenoso limoso color gris a marrón poco compacto, moderadamente permeable y con filtración de agua, nivel superior a 10 m. de la rasante actual. En el sector filtración hacia la parte inferior, esta compuesta de material fluvio glaciar con matriz arcillo limoso bien compacto. La zona que representa este tipo de material esta limitado por el nivel de filtración hasta el km 237+600 aproximadamente.

FOTOGRAFÍAS DE AFLORAMIENTO - ESTACIÓN GEOTÉCNICA



FICHA DE ESTACIÓN GEOTÉCNICA 02

COORDENADAS: X: 340347.017 Y: 8477381.401 Z: 2522.000 ESTACIÓN N°: S-2
 FECHA: dic-15 Calidad de afloramiento: Buena

| Profundidad | Desde | | 0 m | |
|--|--------------------------------------|---------------------|-------|--|
| | Hasta | | 2m | |
| Granulometría estimada | Total (Volumen) | T. Max (pulg) >50 | 0.50 | |
| | | Clastos % > 12 | 1.00 | |
| | | Bolones (%>3" <12") | 2.00 | |
| | Fracción bajo tamiz 3" (Peso) | Resto (>3") | 6.00 | |
| | | Grava (%) | 50.00 | |
| | | Arena (%) | 16.00 | |
| | Fino (%) | 24.40 | | |
| Color en Estado Natural / Olor | Gris a marrón | | | |
| Graduación / Dilatancia | Mala | | | |
| Tipo de granos | Grava, arena, limo y bloques | | | |
| Forma de partículas | sun angulosos | | | |
| Dureza de partículas | R3 - R4 | | | |
| Angularidad de Partículas / Resistencia seca | 60° - 90° | | | |
| Humedad | 10 | | | |
| Plasticidad | NP | | | |
| Consistencia o Compacidad | Moderadamente denso | | | |
| Estructura | Posible contacto con roca fracturada | | | |
| Cementación | Nula | | | |
| Reacción al HCL | Sin Reacción | | | |
| Materia Orgánica o raíces | > 0.20 m | | | |
| Origen Geológico | Fluvio Glaciar | | | |
| Resistencia a la Excavación | media | | | |
| AASHTO | A-1b (0) | | | |
| Símbolo del Grupo USCS | GC - GM | | | |
| Nombre local del Suelo | Depósito fluvio glaciar | | | |

| Índice de Meteorización (WI) | | |
|-----------------------------------|-----|-------------|
| W2 | | |
| Moderadamente meteorizado | | |
| Índice de Dureza (SI) | | |
| Bloques | R4 | Roca dura |
| Matriz | R-1 | Suelo débil |
| Condición de Agua (GW) | | |
| 7 | | |
| Húmedo | | |
| Índice de Resist. Geológica (GSI) | | |
| 20 | | |

Tipo y Descripción del suelo:
 Material de origen fluvio glaciar, compuesto de bloques sub angulosos de roca metalimolita y metacuarcita, envueltos en matriz grava arcillo limosa arenosa, color gris a marrón poco compacto, moderadamente permeable sin agua. La zona que representa este tipo de material fluvio glaciar, esta cubierta por vegetación baja, razón por esta es fácil visualizar afloramientos representativos. Clasificación de acuerdo Sistema Unificado de Suelos (GC - GM). = Grava arcillo limosa con arena y bolones. Según AASHTO es clasificado como: Fragmentos de roca, grava y arena (A - 1b (0))

FOTOGRAFÍAS DE AFLORAMIENTO - ESTACIÓN GEOTÉCNICA

