Tasmania Department of Resources and Energy

Division of Mines and Mineral Resources — Report 1990/32

Seismic refraction survey at a proposed dam site on Distillery Creek

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Introduction

The Division of Mines and Mineral Resources was requested by the Hydro-Electric Commission to undertake a seismic refraction survey of a proposed dam site at Distillery Creek near Nunamara. The traverses were made with five metre geophone spacing, shots being fired at the end geophone positions, near the mid point of the traverse and beyond the end of the traverse. Two weathering spreads with variable geophone spacings were also made.

Vehicular access to the site was restricted because of water-logged paddocks. A four-wheel drive vehicle was used to transport equipment to the site and a support vehicle was used for daily transport to a nearby homestead. Delays were occasioned by rain, thunder and lightning.

Geological setting

The area is mapped on the Geological Atlas 1:63,360 scale Launceston sheet as Quaternary-age river alluvium occupying the floor of a valley which at the proposed site narrows between two hills of Jurassic age dolerite. The proposed dam abutments are located on the hills of dolerite. In the valley, large boulders of fresh to slightly weathered dolerite occur at the surface. They are contained within a high plasticity clay. In places sheets of dolerite occur at the surface. A small knoll, locally termed Morses Knob, is located centrally within the valley near the axis of the proposed dam.

In places a fine size lateritic gravel is present at the surface. Sediments, possibly of Tertiary age, were revealed by the shot holes at the northwestern end of G and E lines.

Weathering spreads

Two weathering spreads were made using hammer and plate near the intersection of seismic lines fired previously by the HEC and those fired during this survey. The surface layer velocity recorded is that of sound in air. This is taken to indicate that the surface materials have a seismic velocity slower than the speed of sound in air. The next recorded layer had a velocity of 670 m/s and is taken to represent clayey materials. The next layer had erratic arrival times and is thought to indicate the main refractor. Velocities vary in this refractor and may indicate ray paths through dolerite boulders as well as through in situ dolerite.

General comments on the seismic survey

Erratic time distance plots were expected and obtained without exception. Small variations in the surface layer thickness, and composite ray paths through fresh dolerite boulders and clayey materials in the near surface region, are factors contributing to this erratic response. Classic seismic refraction survey interpretation techniques rely on the presence of isotropic materials which are sub-horizontally layered with the velocity of the underlying layer being greater than the overlying one. In dolerite country these requirements are rarely obtained. Dolerite is usually strongly jointed, often both sub-vertically and sub-horizontally. Weathered zones can be of significant thickness or lateral extent.

Interpretations have been made using the intercept time and critical distance methods on the segment velocities recorded. Ambiguities between adjacent spreads and at mid point shots arise and no effort has been made to resolve these using those techniques. Reciprocal time methods have been applied wherever possible. The beyond end of traverse shots usually closely mimic the end shots. The beyond end of traverse shots have been used in an attempt to provide 'phantom' arrivals for the end shots and in deriving the main refractor velocity. A simple two-layer situation, usually with surface velocity of 670 m/s, has been modelled.

It is stressed that the interpretations are not rigid and are provided as a guide to indicate areas where changes in conditions are likely to occur.

The results are presented as interpreted profiles with an assumed horizontal ground surface. Table 1 lists the arrival times.

Seismic line F

In general, the main refractor has a high velocity (in excess of 2800 m/s) and occurs within three metres of the surface. Several peaks and troughs are indicated and are associated with slow (down-dip) velocity when fired in one direction and very fast (up-dip) velocity when fired in the opposite direction. The major feature on this line is the sudden change near stations F16/F17 and F24/F25. The latter roughly corresponds to a change in slope which is discernible in the field.

Seismic line G

The main feature of this line is the considerable depth to the main refractor at the northwest end of the line and the apparent shallowing of the main refractor towards the southeast end of the line. The reciprocal time interpretation (two-layer model) for stations G1–G13 does not appear to be valid. The time distance curves strongly indicate an intermediate layer with velocity less than 1700 m/s. This intermediate layer may be Tertiary-age sediments infilling a former valley and/or extremely weathered dolerite.

Seismic line E

The HEC had previously surveyed part of this line. The present survey extended the previous work in both the southeast and northwest directions.

Southeast extension

The general trend here is for very erratic time distance curves with the main refractor at relatively shallow depth. Several peaks and troughs are indicated and match well with up-dip/down-dip velocity segments. Overall travel times from the end shots are between 20 and 30 milliseconds.

Northwest extension

The overall travel times for the end shots on this traverse are near 40 milliseconds. A significant change occurs between this traverse and the others on the southeast extension of the E line. An intermediate layer is almost certainly present and has a velocity less than 1700 m/s and probably closer to 1000 m/s. The intermediate layer may be extremely weathered dolerite, or more probably Tertiary-age sediments. These are indicated from material exposed beyond the end of traverse shot at E24 and by materials encountered in borehole 670.

Additional shots are required on this line to adequately model the three-layer situation. These were not fired due to time constraints. A two-layer interpretation using relatively low velocities is provided as a guide only.

Conclusions

Erratic time-distance plots are expected in dolerite. terrain, particularly where the dolerite is jointed and has been subject to deep weathering. The plots make classic interpretations difficult as the basic assumptions required by the physics of the refraction equation (Snell's law) are invalid. An attempt has been made to interpret the time-distance curves as best as possible.

Significantly, the overall travel times for line G and the northwest extension of line E, are greater than those on line F and the southeast extension of line E. It is considered that the dolerite is more deeply weathered where the travel times are greater and/or that Tertiary age sediments may be present between the surface and the main dolerite refractor.

[3 August 1990]

TABLE 1

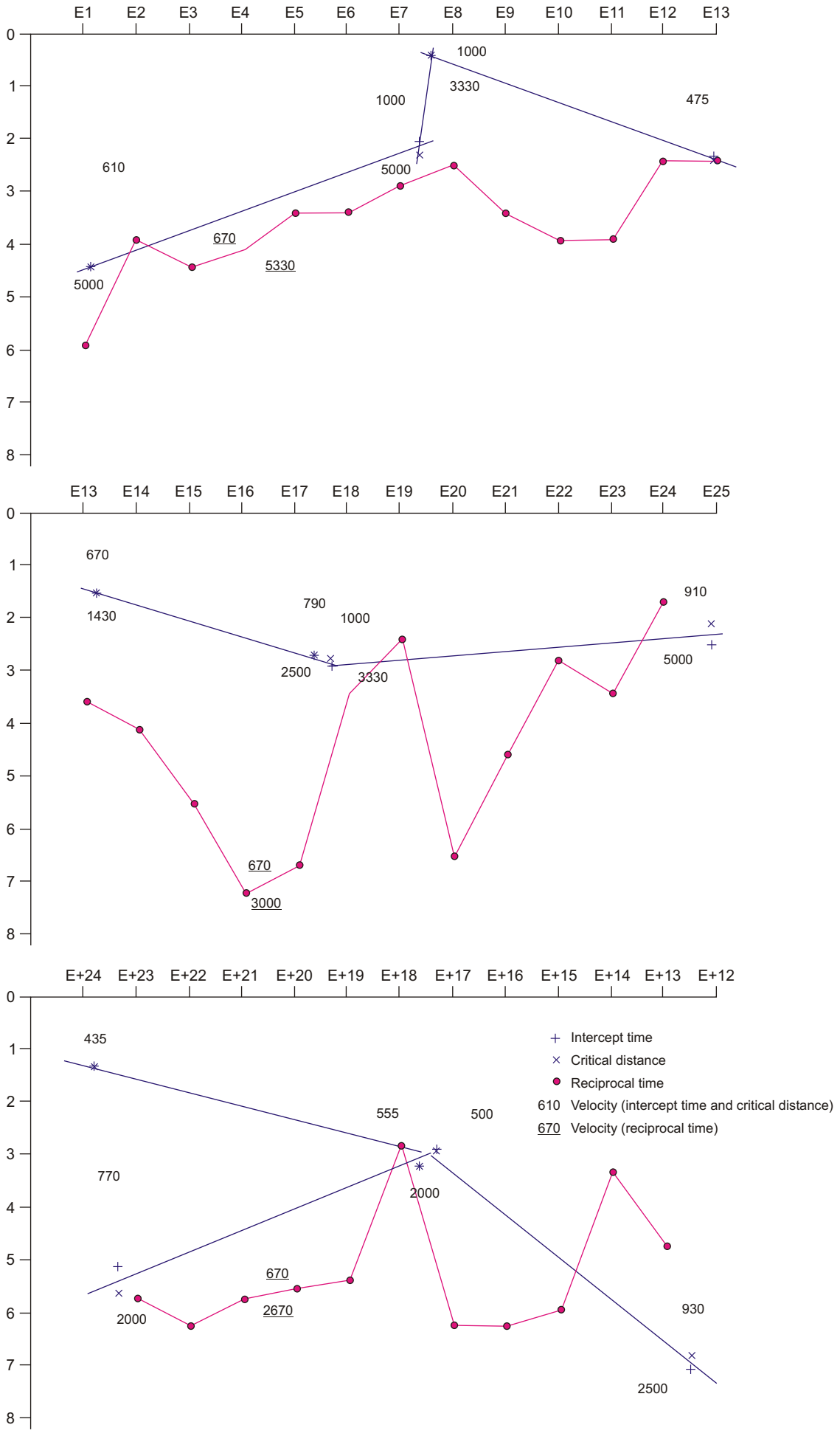
Distillery Creek seismic refraction survey, travel times

* indicates non-functioning geophone or poor record

SHOT STATION	E+4	E-l	E-7/E-8	E-13	E-17
E-1	14.5	0	*	27	*
E-2	13	8	9.5	22.5	25
E-3	15.25	16.5	10.5	22	24.5
E-4	14.75	18	10	21	23.5
E-5	15	18.5	6.5	18.5	21.5
E-6	16.5	19.5	5.5	17.5	20
E-7	17	20.5	2.5	15	17.5
E-8	19	21.5	1.5	13	16
E-9	*	24	3	*	*
E-10	27.5	25	12	*	21
E-11	28	27.5	13.5	11	18
E-12	30	29	14	10.5	16.5
E-13	*	29.5	*	0	14.5

SHOT STATION	E-9	E-13	E-18/E-19	E-24	E-26
E-13	12.5	0	*	15.5	*
E-14	13	7.5	12	16.5	16.5
E-15	15.5	o 11	12.5	18	19
E-16	20	18	11.5	18.5	19
E-17	21	19	9.5	16	16.5
E-18	17	15.5	3	10	11
E-19	16.5	14.5	2.5	8	9
E-20	21	21.5	7.5	13	14.5
E-21	22.5	20.5	9	8.5	9.5
E-22	20.5	18.5	7.5	5	6
E-23	23	20	8.5	5.5	5.75
E-24	*	*	10.5	0	*

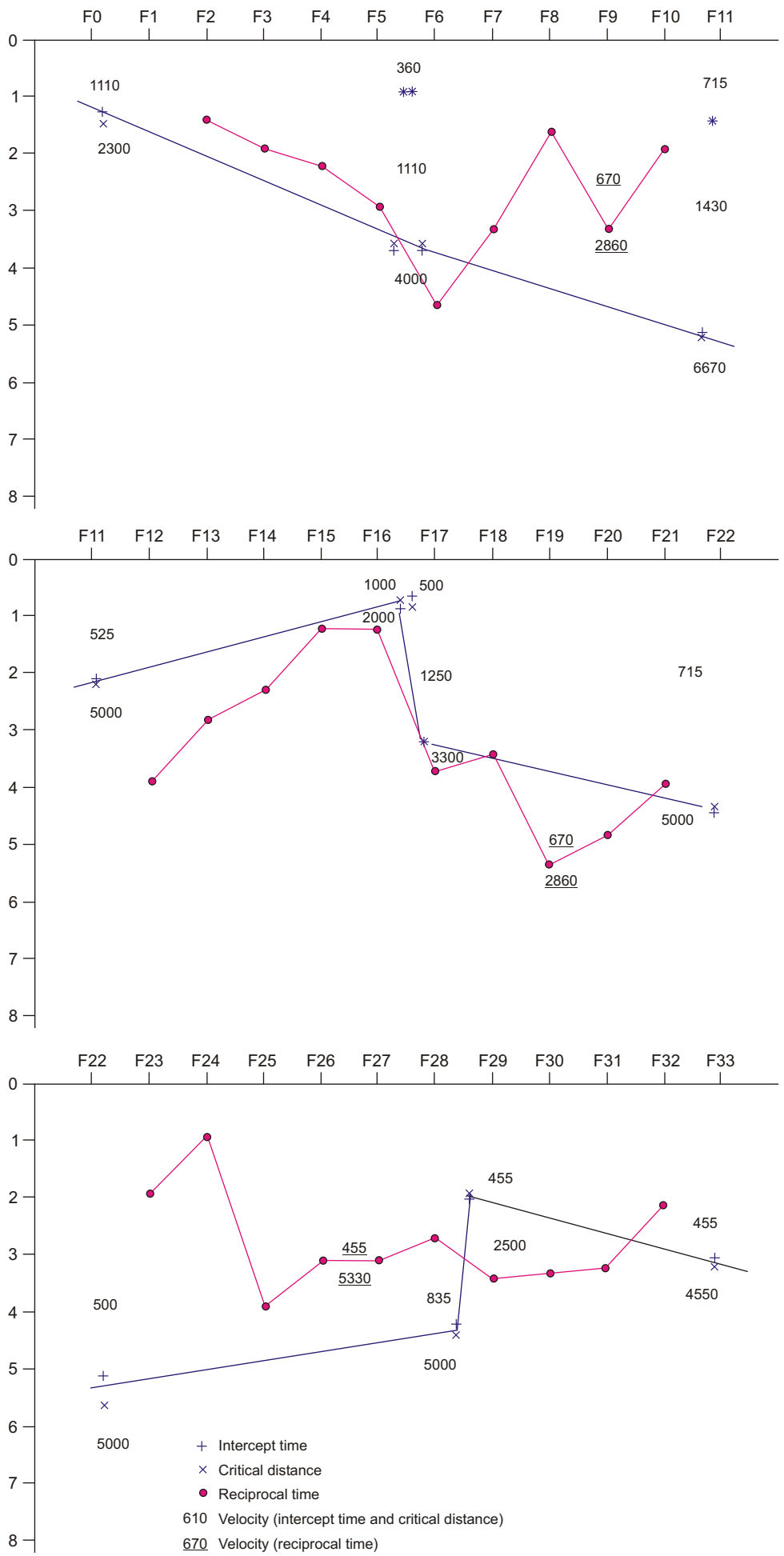
SHOT STATION	E+7	E+12	E+17/E+18	E+24	E+24 +30 m
E+24	*	38	*	0	*
E+23	39	33.5	30	11.5	34.5
E+22	38	33	27	18	37
E+21	33.25	31	20	23	37
E+20	33.5	29	17.5	25.5	38.5
E+19	31.5	28	13.5	27	40
E+18	25.5	21.5	4.5	26	37.5
E+17	29	24.5	4	33	45
E+16	25.5	. 21.5	15	36	48
E+15	22.5	16	21	38	49.5
E+14	18.5	11	19.5	34.5	47
E+13	18.5	8	23	38.5	50
E+12	*	0	25.5	39.5	54.5


E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 E12 E13
0 1 2 3 4 5 6 7 8
1000
3330
1000
475
610
5000
670
5330
5000
E13 E14 E15 E16 E17 E18 E19 E20 E21 E22 E23 E24 E25
670
1430
790
1000
910
5000
2500
3330
670
3000
E+24 E+23 E+22 E+21 E+20 E+19 E+18 E+17 E+16 E+15 E+14 E+13 E+12
435
555
500
770
2000
670
2000
2670
930
2500
Intercept time
Critical distance
Reciprocal time
610 Velocity (intercept time and critical distance)
670 Velocity (reciprocal time)

SHOT STATION	F0+25 m	F0	F5/F6	F11	F15
F0	*	0	17.5	21	22
F1	17	4.5	*	17	18
F2	18	6.5	14	18	18
F3	20.5	9	12.5	17	17
F4	22.5	11	11.5	16	16
F5	23	*	7	17.5	17
F6	29	18.5	7	15.5	16.5
F7	28.5	18	11.5	12	13
F8	26	15.5	10.5	9.5	10
F9	30.5	19.5	14	10.5	12
F10	30	19	14.5	7	8
F11	30.5	20	*	0	*

SHOT STATION	F8	F11	F16/F17	F22	F25
F11	11	0	*	22.5	26
F12	13	9.5	13	25	27.5
F13	13.5	10.5	9.5	21	24.5
F14	14	11	7.5	19	22.5
F15	12.5	10	5	17	19
F16	13.5	11	2.5	16	19.5
F17	18.5	17.5	5	*	20
F18	18	17	9	16	19
F19	23.5	21.5	14.5	17	20
F20	22.5	20.5	13	14	19.5
F21	24	*	14.5	7	15.5
F22	25.5	*	18	0	*

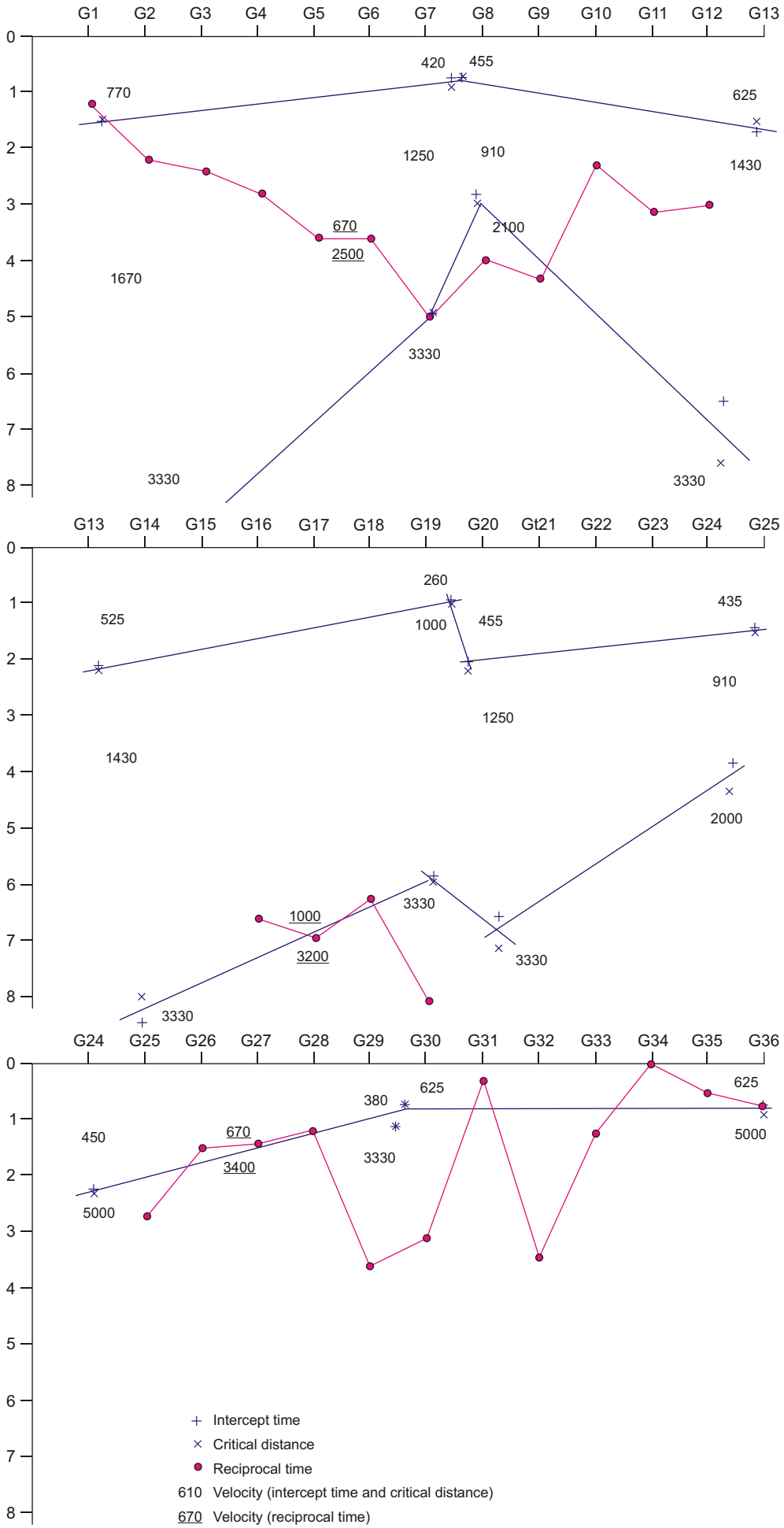
SHOT STATION	Fl 7	F22	F28/F29	F33	F37
F22	*	0	*	26	30. 5
F23	16.5	10	16.5	24	28. 5
F24	13.5	9.5	15.5	20	24.5
F25	21	18	16	24.5	27.5
F26	19.5	18	13	21	25.5
F27	21	19	9	20	25.5
F28	20.5	19	3	18.5	24.5
F29	23.5	22	5.5	18.5	23
F30	24	22.5	11	17.5	*
F31	25.5	*	14	15.5	22
F32	26	23.5	13.5	11	20.5
F33	27	25	17	0	*


F0 F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 F11
0 1 2 3 4 5 6 7 8
1110
2300
360
1110
4000
715
670
1430
2860
6670
F11 F12 F13 F14 F15 F16 F17 F18 F19 F20 F21 F22
0 1 2 3 4 5 6 7 8
1000
500
2000
525
5000
1250
715
3300
5000
670
2860
F22 F23 F24 F25 F26 F27 F28 F29 F30 F31 F32 F33
0 1 2 3 4 5 6 7 8
455
455
2500
455
5330
500
835
4550
5000
5000
Intercept time
Critical distance
Reciprocal time
610 Velocity (intercept time and critical distance)
670 Velocity (reciprocal time)

SHOT STATION	G1+30 m	G1	G7/G8	G13	G17
G1	*	0	*	32.5	53
G2	21.5	6.5	20	27.5	39.5
G3	24	10.5	16.5	25.5	37
G4	26	12	15	25	37
G5	28.5	15	14	24.5	36.5
G6	30.5	18	10	21.5	34
G7	32	21	6	22.5	33
G8	33.5	21.5	5.5	19	31
G9	35	24	11	17.5	31
G10	34	23	11.5	12.5	27
G11	35.5	26.5	15.5	11.5	28
G12	36.5	27.5	17	8	26.5
G13	49	29	20.5	0	*

SHOT STATION	G7	G13	G19/G20	G25	G31
G13	*	0	26	33	48
G14	22	9.5	24	31.5	35.5
G15	23	14.5	23	31	36
G16	25.5	18	21.5	31	36.5
G17	27.5	21	19	30	35
G18	28	22.5	14.5	28	33
G19	31.5	25.5	9.5	28	33
G20	32	26	5.5	25.5	30.5
G21	31.5	25.5	14.5	22.5	28
G22	36.5	27	18.5	20	26
G23	37	28.5	21.5	17	25
G24	37.5	29.5	23	11.5	23.5
G25	44	30.5	*	0	*

SHOT STATION	G19	G24	G29/G30	G36
G24	*	0	21.5	26.5
G25	27	11	19.5	24.5
G26	24.5	12	13	20
G27	25.5	15	9.5	16.5
G28	24.5	16	8	15
G29	30.5	21.5	6.5	16.5
G30	29.5	22	4	14.5
G31	28.5	19.5	8	9
G32	33	25	13	12.5
G33	32	23.5	14	7.5
G34	32	23	12.5	4.5
G35	34.5	25.5	17	3.5
G36	38	29.5	*	0


G1 G2 G3 G4 G5 G6 G7 G8 G9 G10 G11 G12 G13
0 1 2 3 4 5 6 7 8
420 455
770
625
1250 910
1430
670
2500
2100
1670
3330
3330
3330
G13 G14 G15 G16 G17 G18 G19 G20 Gt21 G22 G23 G24 G25
0 1 2 3 4 5 6 7 8
260
525
1000 455
435
910
1250
1430
2000
1000
3330
3200
3330
3330
G24 G25 G26 G27 G28 G29 G30 G31 G32 G33 G34 G35 G36
0 1 2 3 4 5 6 7 8
625
380
625
450
670
5000
3400
3330
5000
+ Intercept time
× Critical distance
Reciprocal time
610 Velocity (intercept time and critical distance)
670 Velocity (reciprocal time)