VIDE

Containment Data Report

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VIDE Instrumentation Summary

Instrumentation	Fielded on this Event	Data Return	Present in this Report
<u>Plug Emplacement</u>	yes	yes	no
<u>Radiation</u>	yes	yes	yes
<u>Pressure</u>			
Stemming	yes	yes	yes
Challenge	no	-	-
Cavity	no	-	-
Atmospheric	no	-	-
<u>Motion</u>			
Free Field	yes	yes	yes
Surface	yes	yes	yes
Plug	yes	yes	yes
Stemming	no	-	-
Surface Casing	no	-	-
Emplacement Pipe	no	-	-
<u>Hydroyield (a)</u>	yes	yes	no
<u>Collapse (b)</u>	yes	yes	yes
<u>Stress</u>	yes	yes	yes
<u>Strain(c)</u>	yes	no	-
<u>Other Measurements</u>	no	-	-

- (a) CORTEX or SLIFER in emplacement hole.
(b) EXCOR or CLIPER in emplacement hole.
(c) Emplacement pipe load.

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1. Event Description

1.1 Site

The VIDE event was detonated in hole U8k of the Nevada Test Site as indicated in figure 1.1. The device had a depth-of-burial (DOB) of 327 m in the bedded tufts of area 9, about 200 m above the Paleozoic and the standing water level, as shown in figures 1.2 and 1.3⁽¹⁾. Stemming of the 1.83 m diameter emplacement hole followed the plan shown in figure 1.4. A log of the stemming operations was maintained by Holmes & Narver⁽²⁾.

Detonation time was 07:35 PDT on April 30, 1981 and 53.5 minutes later a subsurface collapse or stemming fall to a depth of about 180 m occurred.

No radiation arrivals were detected in the emplacement hole above the bottom stemming plug and the VIDE containment was considered successful.

1.2 Instrumentation

Figure 1.5 is a schematic layout of the instrumentation designed to monitor the emplacement procedures and stemming performance of the VIDE event.

The three stemming plugs were composed of coal-tar epoxy (LAE 59, denoted CTE). A soft layer of coal-tar and aggregate (LAE 59MY, denoted CTA) was poured on the top of each of the plugs to act as a gas seal.

Pressure and radiation was monitored in the coarse stemming about 6 m above and below surfaces of each of two bottom stemming plugs and about 4.5 m below the top plug. Four similar stations were fielded in the coarse stemming between the device canister and the bottom plug.

Vertical motion was monitored in each of the three plugs in the emplacement hole and in the ground surface, 15.24 m from SGZ. An array of fourteen motion stations was fielded on a line 30° north of west from surface ground zero (SGZ) with each buried 0.91 m in the ground surface. The closest station to SGZ was at a distance of 300 m while each succeeding station was 60 m farther away. Vertical motion was monitored at each of the fourteen stations but, because of a limitation of both available transducers and recording channels, tri-axial motion was monitored at only four stations and an additional four measured bi-axial motion (horizontal-radial and vertical components). The purpose of these measurements was to use a nuclear event as the source for a coarse, single-ended seismic survey through the faults exposed by another nuclear event (DISCUS THROWER, U8a).

As part of a continuing effort to develop an in-situ dynamic stress transducer, four elevations were instrumented with stress and strain transducers .

Data from each of the above instruments were transmitted to the recording trailer by an analog system and recorded on magnetic tape.

D-cable information was used for quality assurance during the stemming operations.

Three CLIPER/CORRTEX sensors were emplaced in the emplacement hole to measure the hydrodynamic yield of the device and to monitor cavity collapse and chimney formation; one on the emplacement pipe and device canister, a second on the instrumentation pendant and a third on a prompt gas sample hose (not shown in figure 1.5). Results of the yield measurements are reported elsewhere⁽³⁾.

A history of the fielding operations of the instrumentation, including the emplacement pipe strain measurements, is outlined in reference 4. Details of the instrumentation are given in reference 5.

1.3. Emplacement

A single strain station (93) was fielded near the top of the emplacement pipe to monitor the load during installation and stemming. This station was monitored randomly during these procedures and was recorded by hand during the device installation only. Emplacement was detailed by Holmes & Narver⁽²⁾. The stemming plugs consisted of four "LAE 59" coal-tar epoxy (CTE) plugs. The bottom three were about 4 m thick while the top was about 6 m thick. The bottom and the top plugs were capped with about 1.8 m of soft coal-tar-aggregate "LAE 59MY" epoxy (CTA) to act as a gas sealant. Stemming between the plugs consisted of layers of fines and coarse gravel. The top of the hole (above the top plug) was filled with ground surface derived backfill. See figure 1.4.

Figure 1.1 Map of the Nevada Test Site indicating the location of hole U8k.

Figure 1.2 North-South geologic cross sections through hole U8k.

Figure 1.3 East-West geologic cross sections through hole U8k.

Figure 1.4 As-built stemming plan for the event VIDE in Hole U8k.

Figure 1.5 As-built containment instrumentation plan for the emplacement hole (U8k) on the VIDE event.

2. Stemming Performance

2.1 Radiation and Pressure

As seen in figure 1.5, pressure and radiation was monitored in the coarse stemming at a total of nine stations. Four stations were placed about 6 m above and below the two lower plugs and one station was about 4.5 m below the top plug. An additional four stations were fielded in the coarse stemming between the device canister and the bottom plug.

All stations transmitted data until recording was terminated at about 25 hours after the detonation. Pressure and radiation data recorded during this time are shown in figures 2.1-2.9. Every station shows a brief pulse of radiation which reaches a low-level peak at about 2000 s and vanishes by about 15,000 s. The deepest three stations show a second low-level radiation wave that arrives some time before 10,000 s and reaches a maximum between 35,000 and 60,000 s. This second radiation wave persists until recording is terminated and is not seen at or above station 34 (188 m depth).

To obtain a more accurate first radiation arrival time and to investigate the perturbation seen at about 3200 s in the pressure wave forms of stations 31-34, the first 4000 s of all the pressure and radiation wave forms are shown in figures 2.10-2.18. The pressure drops seen at stations 31-33 (figures 2.10-2.12) are characteristic of a stemming fall, while the pressure jump evidenced at station 34 (figure 2.13) suggests a concurrent stemming compaction around that station. Associated with the pressure drop at stations 31 and 32 is a radiation jump suggesting the presence of radioactive gas introduced with the stemming fall. All stations above 32 show a decrease instead of a radiation increase at this time.

At about 5 minutes after detonation, the Nuclear Chemistry Group usually begins pumping on the prompt gas sample hose and pumping is usually halted shortly after collapse is detected. Shine from the gas sample hose could account for the early, abrupt increase in radiation detected at all stations while the collapse and subsequent halting of pumping can account for the decrease in activity. If this early radiation was due to shine from the prompt gas sample hose then we may conclude that detonation gas reached at least to station 32 and possibly to station 33, but no higher in the stemming

All pressure and radiation data are consistent with satisfactory containment.

Figure 2.1 Pressure and radiation measured in the coarse stemming at 241m depth (Station 31, below the deepest stemming plug 1). Arrival of a second radiation wave occurs at stemming fall (3210 s) and reaches a peak at about 60,000 s.

Figure 2.2 Pressure and radiation measured in the coarse stemming at 226m depth (Station 32, below the deepest stemming plug 1). Arrival of a second radiation wave occurs at stemming fall (3210 s) and reaches a peak at about 60,000 s.

Figure 2.3 Pressure and radiation measured in the coarse stemming at 203m depth (Station 33, below the deepest stemming plug 1). Arrival of a second radiation wave occurs at about 10,000 s and reaches a peak at about 35,000 s.

Figure 2.4 Pressure and radiation measured in the coarse stemming at 188m depth (Station 34, below the deepest stemming plug 1). Only the early-time short pulse of radiation is evident.

Figure 2.5 Pressure and radiation measured in the coarse stemming at 165 m depth (Station 35, below stemming plug 1). The signal conditioner for the pressure channel intermittently lost power at zero time and was replaced upon manual re-entry. Only the early-time short pulse of radiation is evident.

Figure 2.6 Pressure and radiation measured in the coarse stemming at 148 m depth (Station 36, above stemming plug 1). Only the early-time short pulse of radiation is evident.

Figure 2.7 Pressure and radiation measured in the coarse stemming at 90 m depth (Station 37, below stemming plug 2). Only the early-time short pulse of radiation is evident.

Figure 2.8 Pressure and radiation measured in the coarse stemming at 73 m depth (Station 38, above stemming plug 2). Only the early-time short pulse of radiation is evident.

Figure 2.9 Pressure and radiation measured in the coarse stemming at 42 m depth (Station 39, below top stemming plug). Only the early-time short pulse of radiation is evident.

Figure 2.10 The first 4000 s of pressure and radiation measured in the coarse stemming at 241 m depth (Station 31, below the deepest stemming plug 1). Earliest radiation arrival was at about 455s.

Figure 2.11 The first 4000 s of pressure and radiation measured in the coarse stemming at 226 m depth (Station 32, below the deepest stemming plug 1). Earliest radiation arrival was at about 470 s.

Figure 2.12 The first 4000 s of pressure and radiation measured in the coarse stemming at 203 m depth (Station 33, below the deepest stemming plug 1). Earliest radiation arrival was at about 490s.

Figure 2.13 The first 4000 s of pressure and radiation measured in the coarse stemming at 188 m depth (Station 34, below the deepest stemming plug 1). Earliest radiation arrival was at about 505s.

Figure 2.14 The first 4000 s of pressure and radiation measured in the coarse stemming at 165 m depth (Station 35, below stemming plug 1). The signal conditioner for the pressure channel intermittently lost power at zero time and was replaced upon manual re-entry. Earliest radiation arrival was at about 525 s.

Figure 2.15 The first 4000 s of pressure and radiation measured in the coarse stemming at 148 m depth (Station 36, above stemming plug 1). Earliest radiation arrival was at about 540 s.

Figure 2.16 The first 4000 s of pressure and radiation measured in the coarse stemming at 90 m depth (Station 37, below stemming plug 2). Earliest radiation arrival was at about 595s.

Figure 2.17 The first 4000 s of pressure and radiation measured in the coarse stemming at 73 m depth (Station 38, above stemming plug 2). Earliest radiation arrival was at about 615 s.

Figure 2.18 The first 4000 s of pressure and radiation measured in the coarse stemming at 42 m depth (Station 39, below top stemming plug). Earliest radiation arrival was at about 650 s.

2.3 Motion

Explosion-induced histories of the containment related motion measured on the VIDE event are shown in figures 2.19-2.22. Characteristics of the associated motion and transducers are given in tables 2.1–2.3.

Two sets of arrivals are noted in table 2.1 for the down-hole motion stations. The first, traveling at about 3.9 Km/s, is postulated to arise from motion in the emplacement pipe while the second arrival, traveling at about 1.8 Km/s, is close to the sound speed of the medium⁽¹⁾.

2.4 Collapse phenomena

The CLIPER cables in the emplacement hole (stations 91, 93 and "sg") performed as expected, giving the lower position of the cable end as a function of time during the cavity collapse. The cable denoted 91 was attached to the device canister and emplacement pipe, cable 93 was associated with the containment instrumentation pendant, and the cable denoted "gs" was attached to the prompt gas sample hose. These data are shown in figure 2.23 along with pressure wave forms from stations 31 through 34 . CLIPER data indicate that collapse terminated at a depth of about 250 m while the pressure histories suggest that effects of an attendant stemming fall propagated to a depth of about 188 m.

Table 2.1 Summary of Containment-Related Motion

Gauge	Slant Range (m)	Arrival Time (ms)	Acceleration Peak (g)	Velocity Peak (m/s)	Displacement Peak (cm)	Displacement Residual (cm)
21av	163.4	40(a), 91(b)	8.1	0.48(c), 0.43	2.1	1
21uv		39(a), 91	-	0.49(c), 0.42	2.1	0
22av	241.0	60(a), 138	2.7	0.23(c), 0.27	1.3	-0.8
22uv		60(a), 126	-	0.24(c), 0.27	1.4	0.4
23av	287.3	72(a), 160	1.2	0.24	1.3	0.4
23uv		74(a), 161	-	0.25	1.4	-0.2
61av	322.1	190	2.0, 6.7(d)	0.48	2.8	-0.3
61uv		195	-	0.39	2.25	-0.4

(a) Pipe-induced motion.

(b) Estimate.

(c) Precursor.

(d) Slap-down.

Table 2.2 Containment-Related Accelerometer Characteristics

Gauge	Natural Frequency (Hz)	Damping Ratio	System Range (g's)
21av	185	0.65	10
22av	200	0.5	10
23av	195	0.75	4
61av	195	0.72	6

Table 2.3 Containment-Related Velocimeter Characteristics

Gauge	Natural Frequency (Hz)	Time to 0.5 Amplitude (s)	Calibration Temperature (°F)	Operate Temperature (°F)	System Range (m/s)
21uv	3.69	10.2	73.8	82.8	10
22uv	3.42	12.25	74.0	76.0	10
23uv	3.48	10.6	74.1	79.6	12
61uv	3.48	15.4	74.0	60.0	15

Figure 2.19 Explosion-induced vertical motion of the bottom stemming plug at a depth of 158 m (station 21). Traces annotated with "a" are derived from the accelerometer.

Figure 2.20 Explosion-induced vertical motion of stemming plug 2 at a depth of 82 m (station 22). Traces annotated with "a" are derived from the accelerometer.

Figure 2.21 Explosion-induced vertical motion of top plug at a depth of 35 m (station 23). Traces annotated with "a" are derived from the accelerometer.

Figure 2.22 Explosion-induced vertical motion of the ground surface at a horizontal range of 15.24 m and a depth of 0.9 m (station 61).

Figure 2.23 Progression of the collapse as determined from the CLIPER records (stations 91, and 93 and gs). The upper limit of the subsurface collapse in the emplacement hole is indicated to be at a depth of about 250 m. The pressure records from the four stations below the bottom plug suggest that the stemming fall progressed upwards for another 70 m.

3. Surface array measurements

As noted earlier, the purpose of these measurements was to use a nuclear event as the source for a coarse, single-ended seismic survey through the faults exposed by another nuclear event (DISCUS THROWER, U8a). Figures 3.1 - 3.26 show the motion obtained from the surface array lying on a line 30 degrees north of west from U8k. The first station was at a horizontal range of 300 m from U8k with each succeeding station 60 m farther along. All stations were buried 0.91 m in the ground surface. Four of the fourteen stations included tri-axial motion measurements (vertical, horizontal-radial, and horizontal-transverse) and an additional four included bi-axial measurements (vertical and horizontal-radial). Positive sense motion was vertical, radial outward, and clockwise looking down on the station. Tables 3.1 - 3.3 summarize the motion and the motion transducer properties.

First arrivals of the motion are plotted in figure 3.27 while figures 3.28 and 3.29 shows the peak acceleration and velocity as a function of range from the detonation point. Both vertical and horizontal- radial motion are represented in figures 3.27 - 3.29.

Table 3.1 Summary of Surface Array Motion

Gauge	Slant Range (m)	Arrival Time (ms)	Acceleration Peak (g)	Velocity Peak (m/s)	Displacement Peak (mm)
62av	445.7	273	0.72	0.17	8.6
62uv		273	-	0.19	8.6
62ar		273	0.47	0.12	7.5
62at		288	0.03	0.006	8.5
63av	489.3	294	0.46	0.14	6.2
63uv		302	-	0.12	4.7
64av	535.9	324	0.43	0.110	4.8
64uv		324	-	0.114	4.1
64ar		315	0.49	0.136	6.8
65av	585.3	353	0.35	0.096	3.9
65uv		354	-	0.098	3.7
66av	636.4	372	0.31	0.084	3.3
66uv		373	-	0.096	3.7
66ar		375	0.35	0.111	5.2
66at		380	0.052	0.017	1.1
67av	689.1	409	0.23	0.072	2.9
67uv		408	-	0.075	2.9
67ar		405	0.35	0.107	4.6
68av	742.7	430	0.163	0.053	2.3
68uv		436	-	0.066	3.0
68ar		425	0.255	0.089	4.3
69av	797.3	468	0.14	0.05	2.4
69uv		464	-	0.05	2.4

Table 3.1 Summary of Surface Array Motion (continued)

Gauge	Slant Range (m)	Arrival Time (ms)	Acceleration Peak (g)	Velocity Peak (m/s)	Displacement Peak (mm)
70av	853.3	482	0.115	0.049	2.3
70uv		489	-	0.064	2.9
70ar		485	0.13	0.051	2.4
70at		485	-0.12	-0.047	-2.4
71av	908.8	511	0.14	0.052	2.2
71uv		517	-	0.062	2.6
72av	965.8	545	0.14	0.044	1.8
72uv		552	-	0.043	1.85
72ar		540	0.165	0.058	2.7
73av	1021.7	562	0.16	0.05	2.0
73uv		562	-	0.05	2.1
74av	1080.1	547	0.10	0.032	1.3
74uv		560	-	0.038	1.6
74ar		590	0.052	0.017	0.77
74at		610	-0.012	-0.0035	-0.12
75av	1137.7	540	0.057	0.016	0.74
75uv		546	-	0.018	0.86

Note: Positive values denote vertical upward (v), horizontal-radial outward (r), and horizontal-transverse with clockwise motion (t).

Table 3.2 Surface Array Accelerometer Characteristics

Gauge	Natural Frequency (Hz)	Damping Ratio	System Range (g's)
62av	150	0.65	3
62ar	280	0.60	3
62at	140	0.75	3
63av	142	0.65	3
64av	251	0.75	3
64ar	239	0.65	3
65av	210	0.75	3
66av	240	0.65	3
66ar	262	0.65	3
66at	269	0.60	3
67av	270	0.85	3
67ar	200	0.65	3
68av	178	0.65	2
68ar	74	0.65	2
69av	170	0.65	2
70av	118	0.65	2
70ar	70	0.65	2
70at	140	0.75	2
71av	141	0.65	2
72av	112	0.70	1
72ar	110	0.65	1
73av	132	0.65	1
74av	74	0.65	1
74ar	108	0.65	1
74at	120	0.65	1
75av	68	0.65	1

Table 3.3 Surface Array Velocimeter Characteristics

Gauge	Natural Frequency (Hz)	Time to 0.5 Amplitude (s)	Calibration Temperature (°F)	Operate Temperature (°F)	System Range (m/s)
62uv	3.55	9.5	74.2	60.9	1
63uv	3.40	9.4	75.4	63.3	1
64uv	3.60	13.9	74.5	63.1	1
65uv	3.49	12.7	74.7	62.7	1
66uv	3.62	12.8	74.5	61.7	1
67uv	3.50	11.9	73.5	63.1	1
68uv	3.31	15.2	73.7	62.5	1
69uv	3.28	19.3	73.8	63.9	1
70uv	3.25	25.0	75.1	63.7	1
71uv	3.43	13.4	73.7	63.9	1
72uv	3.46	13.2	72.8	63.9	1
73uv	3.62	10.9	73.5	65.1	1
74uv	3.51	10.8	73.8	63.5	1
75uv	3.24	22.5	74.3	65.9	1

Figure 3.1 Vertical motion of the ground surface at a slant range of 445.7 m and a depth of 0.91 m (station 62).

Figure 3.2 Horizontal-radial motion of the ground surface at a slant range of 445.7 m and a depth of 0.91 m (station 62).

Figure 3.3 Horizontal-transverse motion of the ground surface at a slant range of 445.7 m and a depth of 0.91 m (station 62).

Figure 3.4 Vertical motion of the ground surface at a slant range of 489.3 m and a depth of 0.91 m (station 63).

Figure 3.5 Vertical motion of the ground surface at a slant range of 535.9 m and a depth of 0.91 m (station 64).

Figure 3.6 Horizontal-radial motion of the ground surface at a slant range of 535.9 m and a depth of 0.91 m (station 64r).

Figure 3.7 Vertical motion of the ground surface at a slant range of 585.3 m and a depth of 0.91 m (station 65).

Figure 3.8 Vertical motion of the ground surface at a slant range of 636.4 m and a depth of 0.91 m (station 66).

Figure 3.9 Horizontal-radial motion of the ground surface at a slant range of 636.4 m and a depth of 0.91 m (station 66).

Figure 3.10 Horizontal-transverse motion of the ground surface at a slant range of 636.4 m and a depth of 0.91 m (station 66).

Figure 3.11 Vertical motion of the ground surface at a slant range of 689.1 m and a depth of 0.91 m (station 67).

Figure 3.12 Horizontal-radial motion of the ground surface at a slant range of 689.1 m and a depth of 0.91 m (station 67).

Figure 3.13 Vertical motion of the ground surface at a slant range of 742.7 m and a depth of 0.91 m (station 68).

Figure 3.14 Horizontal-radial motion of the ground surface at a slant range of 742.7 m and a depth of 0.91 m (station 68).

Figure 3.15 Vertical motion of the ground surface at a slant range of 797.3 m and a depth of 0.91 m (station 69).

Figure 3.16 Vertical motion of the ground surface at a slant range of 853.3 m and a depth of 0.91 m (station 70).

Figure 3.17 Horizontal-radial motion of the ground surface at a slant range of 853.3 m and a depth of 0.91 m (station 70).

Figure 3.18 Horizontal-transverse motion of the ground surface at a slant range of 853.3 m and a depth of 0.91 m (station 70).

Figure 3.19 Vertical motion of the ground surface at a slant range of 908.8 m and a depth of 0.91 m (station 71).

Figure 3.20 Vertical motion of the ground surface at a slant range of 965.8 m and a depth of 0.91 m (station 72).

Figure 3.21 Horizontal-radial motion of the ground surface at a slant range of 965.8 m and a depth of 0.91 m (station 72).

Figure 3.22 Vertical motion of the ground surface at a slant range of 1021.7 m and a depth of 0.91 m (station 73).

Figure 3.23 Vertical motion of the ground surface at a slant range of 1080.1 m and a depth of 0.91 m (station 74).

Figure 3.24 Horizontal-radial motion of the ground surface at a slant range of 1080.1 m and a depth of 0.91 m (station 74).

Figure 3.25 Horizontal-transverse motion of the ground surface at a slant range of 1080.1 m and a depth of 0.91 m (station 74).

Figure 3.26 Vertical motion of the ground surface at a slant range of 1137.7 m and a depth of 0.91 m (station 75).

Figure 3.27 Arrival times of the first motion as a function of distance from the detonation point. Both vertical and horizontal-radial motion are represented.

Figure 3.28 Peak initial acceleration as a function of distance from the detonation point. Both vertical and horizontal-radial motion are represented.

Figure 3.29 Peak initial velocity as a function of distance from the detonation point. Both vertical and horizontal-radial motion are represented.

4. Stress measurements

As part of a continuing effort to develop a transducer to measure in-situ stress, a composite stress and strain transducer (the internal structure of which is shown in figure 4.1) was developed by Dynasen, Inc⁽⁶⁾. Figures 4.2-4.5 show the output from eight of the composite transducers (radial and horizontal orientations) at four elevations in coarse stemming of the emplacement hole.

Three additional single element (flat-pack) horizontal stress transducers, developed by SRI, were also fielded at nearly the same elevations as the composite gauges of stations 2, 3, and 4. (See figure 1.5 for the exact elevations.) The internal structure of these is schematically shown in figure 4.6.

The outputs from the flat-pack gauges are shown in figures 4.7-4.9 wherein the amplitudes are given in units of percent resistance change. Resistance of each element is given in the associated plot.

The calibrations of the SRI transducers were defective leading to suspicion of the transducers themselves. Data from only the gauges at the elevations of stations 2 and 4 are shown for completeness.

Figure 4.1 Structure of composite gauge showing the two piezoresistive elements (Ytterbium and Carbon) and the strain transducers (Constantan). The grids were installed in both horizontal and radial orientations.

Figure 4.2

Output of composite stress-strain gauges of station 1 at a depth of 301.1 m (21.4 m from the reference depth). The initial resistance of each grid is shown in its corresponding plot.

Figure 4.3

Output of composite stress-strain gauges of station 2 at a depth of 294.3 m (28.2 m from the reference depth). The initial resistance of each grid is shown in its corresponding plot.

Output of composite stress-strain gauges of station 3 at a depth of 283.2 m (39.3 m from the reference depth). The initial resistance of each grid is shown in its corresponding plot.

Figure 4.5

Output of composite stress-strain gauges of station 4 at a depth of 272.1 m (50.4 m from the reference depth). The initial resistance of each grid is shown in its corresponding plot.

Figure 4.6 Structure of Ytterbium flat-pack stress gauge developed at SRI.

Figure 4.7 Output of Ytterbium flat-pack stress transducers mounted at station 2 at a depth of 294.15 m (28.38 m from the reference depth) and station 4 at a depth of 272.13 m (50.40 m from the reference depth). These records are shown only for completeness. The initial resistance of each grid is shown in its corresponding plot.

References

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