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U.S. DEPARTMENT OF THE INTERIOR
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HYBRID-SOURCE SEISMIC REFLECTION PROFILING ACROSS YUCCA MOUNTAIN, NEVADA: REGIONAL LINES 2 and 3

By

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Open-File Report 95-xxx

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ABSTRACT

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This report describes the acquisition, processing, and preliminary interpretation of regional intermediate-depth seismic reflection lines collected across Yucca Mountain, Nevada, during the fall of 1994. Northern Geophysical of America, under contract to the U.S. Geological Survey (USGS), acquired 37 km of high-fold seismic reflection lines across Yucca Mountain. The principal objectives of this profiling were (1) to track the pre-Tertiary/Tertiary boundary beneath Yucca Mountain, (2) to determine the geometry of faults in the subsurface, and (3) to provide subsurface data to limit the number of structural models for Yucca Mountain. For this reason the reflection lines were run through several existing wells including UE-25 p#1, which penetrated Paleozoic carbonate rocks, and USW VH-1 in Crater Flat. A subsidiary objective was to look for seismic bright spots that could indicate the existence of magma chambers in the middle and lower crust. Geologic mapping, gravity and magnetic data acquired along the lines, several Vertical Seismic Profiles (VSPs), and a seismic refraction model support interpretation of the seismic reflection data.

After testing of field parameters, two seismic lines crossing Yucca Mountain were acquired. Line 2 ran 26 km northeast from Amargosa Desert through Steve's Pass across Crater Flat and Yucca Mountain ending in the vicinity of well UE-25 UZ-16. Line 3, totaling 11 km, trended easterly from well USW H-6 across Yucca Mountain, through well UE-25 p#1, across Fortymile Wash and into Jackass Flats. Lines 2 and 3 intersect several hundred meters east of the crest of Yucca Mountain in the vicinity of well USW SD-7. The seismic data were acquired using a hybrid mix of seismic sources including vibrators, Poulter shots, minihole patterns, and explosive shot holes. The vibrator, Poulter, and minihole sources were used to provide high-fold (60- to 125-fold) sections for the upper 5 seconds of the crustal section; the shot holes were used to provide low-fold (up to 8-fold) images of the middle to lower crust (5 to 10 s).

The inferred top of the Paleozoic section may be traced discontinuously in the reflection data beneath Yucca Mountain, where it is offset by moderate- to high-angle faults. Offset of the Paleozoic/Tertiary contact beneath Yucca Mountain by high- to moderate-angle faults suggests that this contact does not represent an active detachment surface, as proposed by others. Discontinuous reflections along Lines 2 and 3 and VSPs at several wells indicate that a reflector within the Miocene tuffs, probably at or near the top of the Prow Pass Tuff of the Crater Flat Group, subparallels the topographic surface of the east flank of Yucca Mountain at a depth of about 500 m, near the static water level. This reflection appears to have been offset down to the west most noticeably at the Solitario Canyon fault. Westward stratal dips are noted only in the immediate vicinity of the Solitario Canyon fault.

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Seismic reflection Line 2 shows remarkably different images, respectively, for the western and eastern halves of Crater Flat. The seismic and magnetic data show much more lateral continuity of structure and greater Tertiary thicknesses in the western half of the basin than in the eastern half. The seismic data image the Amargosa Desert structural trough, a fault-bounded graben-like structure beneath Crater Flat and Yucca Mountain with a maximum depth of about 3.5 to 4 km. The structural trough is asymmetric: one of a series of northeast-dipping (42°) reflections is interpreted as the western bounding fault, the Bare Mountain range-front fault, truncating a series of west-dipping reflections within the Tertiary fill in Crater Flat to a depth of at least 3.5 km. The eastern boundary is defined by a series of antithetic down-to-the-west normal faults, between the Solitario Canyon and Paintbrush Canyon faults, which together are inferred to drop the top of the Paleozoic sequence between 750 and 1000 m beneath Yucca Mountain.

Gently dipping, shallow reflections between Little Cones and Red Cone, inferred to be basaltic flows dated between 3.7 to 11 Ma, indicate that only minor (less than 12 m) faulting of the southwestern part of Crater Flat has occurred since the basaltic flows erupted. In the eastern half of Crater Flat, reflections are much more highly disturbed, being offset at intervals of about 1 and 2 km, in agreement with the mapping of numerous faults at the surface and the 1- to 2-km wavelength of magnetic and gravity anomalies.

The uppermost sedimentary sequences in southwestern Crater Flat lie above a major unconformity that deepens westward to over 1 kilometer beneath the surface. The unconformity lies above rocks of the Tiva Canyon Tuff of the Paintbrush Group at well USW VH-1, where the unconformity appears to roll over. This entire sequence is underlain at a depth of nearly 5 km by a subhorizontal, west-dipping reflection within the Precambrian/Paleozoic section, possibly from the Eleana Formation, or, more speculatively, from a mafic intrusion beneath it. Either lithology could produce the broad magnetic anomaly high over Crater Flat, but the anomaly is inconsistent with models incorporating a magnetic source within the Tertiary basin fill.

A reflective lower crust is imaged only on the southwest end of Line 2, in the vicinity of the Amargosa Desert and Steve's Pass. The top of the reflective lower crust is about 15 km deep, and the base of the crust, or Moho, is between 27 and 30 km deep. Neither the explosion nor vibrator sources provided an image of the lower crust in the vicinity of Yucca Mountain or along Line 3. No evidence for a lower-crustal magma chamber (bright spot reflection) was observed in the Amargosa Desert.

Better interpretation of the seismic reflection data will require additional deep boreholes along the seismic reflection lines. In particular, deep boreholes sampling the Paleozoic/Tertiary contact are necessary to test the interpretations presented here.

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INTRODUCTION

In October and November 1994, Northern Geophysical of America (NGA), under contract to the U.S. Geological Survey (USGS), acquired 37 km of high-fold seismic reflection data across Yucca Mountain, Nevada. Yucca Mountain is the site of a potential high-level nuclear waste storage facility currently under evaluation for long-term geological stability (fig. 1A). General objectives of the regional seismic reflection profiling included acquisition of images to describe the boundary between the Tertiary and underlying Paleozoic rocks, to evaluate the presence of a postulated west-dipping subhorizontal detachment surface beneath Yucca Mountain [e.g. Scott, 1990] and possible magma centers in the middle to lower crust [Evans and Smith, 1992], and to identify structural features in the shallow stratigraphic sequence, if possible. Hybrid seismic sources including vibrators, surface-mounted explosive (Poulter) charges [Poulter, 1950], and conventional shallow minihole and deep shot holes were used for data collection in response to environmental, operational, and topographic limitations. Interpretations derived from the seismic reflection profiling will feed into investigations of probabilistic seismic hazards and probabilistic volcanic hazards, and this work may help to discriminate between alternate tectonic models for the Yucca Mountain region. The reflection lines were run through existing wells USW VH-1, USW WT-7, USW UZ-6, USW WT-2, USW SD-7, UE-25 UZ-16, USW H-6, and UE-25 p#1, and close to well USW H-4. In addition, closely spaced measurements of gravity and magnetic fields were made along the seismic lines. This report provides a detailed account of the acquisition, processing, and preliminary interpretation of these seismic reflection data.

Similar seismic reflection testing and profiling were conducted in Amargosa Desert about 20 km south of Yucca Mountain in January 1988 [Brocher and others, 1990]. These tests and success in acquiring Line AV-1 in the Amargosa Desert (fig. 1A) demonstrated that vibrator sources could provide very useful images of the upper crust (0 to 5 seconds of reflection record), and that 45- and 91-kg charges should provide useful images of the lower crust (5 to 10 seconds of record). A detailed comparison of data acquired using vibrator and 91-kg shot hole sources along Line AV-1 was presented by Brocher and Hart [1991]. Brocher and others [1993] presented a geologic interpretation of Line AV-1 and comparison to existing well control and other geophysical profiling. Based partially on these results, further seismic work in the vicinity of Yucca Mountain was recommended [Seismic Methods Peer Review Panel, 1991]. Short, shallow, high-resolution seismic reflection lines acquired on Yucca Mountain in 1993 successfully imaged horizons within the Miocene volcanic tuffs [Daley and others, 1994].

The regional seismic reflection data described in this report were acquired in three stages from October 24 to November 11, 1994. First, we conducted parameter (noise) testing in Crater Flat northeast of USW VH-1, then Line 2 & 2SW, totaling 26 km (16.1 mi), was acquired (fig. 1B). Line 3, totaling 11 km (6.9 mi), was acquired last. The line name, Line 2 & 2SW, resulted

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from a major change in the planning of Line 2. Line 2 was originally planned to incorporate Stations 646 to 1133. Line 2SW, stations 101 to 645, was added to extend the line across Crater Flat and into the Amargosa Desert (fig. 1B). Hereinafter we refer to Line 2 & 2SW simply as Line 2.

NGA Crew 110 (enumerated in Appendix 1 along with subcontractors) provided an I/O System Two recording system, 100 RSX units (which each control 6 geophone groups) and cables, and 695 24-element geophone strings. During our work all data were recorded as 24-bit words at a 2-millisecond sample rate in demultiplexed SEG-D format [Barry and others, 1975]. A complete list of quality-affecting equipment provided by the NGA Crew and their subcontractors is provided in Appendix 2. Survey coordinates for Lines 2 and 3, given as Nevada State Coordinates accurate to a foot in latitude and longitude, are listed in Appendix 3. Horizontal locations in Nevada State Coordinates and elevations, accurate to a tenth of a foot and a hundredth of a foot, respectively, were provided by the surveyors, and were used in data processing. Within this report measurements are first presented in the units in which they were measured; we have converted non-metric units to metric units, typically shown in this report in parentheses after the original measurement.

GEOLOGIC SETTING

Structure

Yucca Mountain is located within the Walker Lane (fig. 1A), a complex northwest-trending zone of oroclinal bending and strike-slip faulting that has been interpreted as dividing the southern Great Basin into two parts: an area to the northeast dominated by extensional faulting, and an area to the southwest in which both strike-slip and extensional faulting are important [e.g., Fox and Carr, 1989; Carr, 1990]. Near Yucca Mountain, steeply westward-dipping extensional faults mapped at the surface have been postulated to be listric normal faults that merge into a west-dipping detachment fault within the upper crust [Scott, 1986, 1990; Fox and Carr, 1989]. Others suggest that steeply-dipping focal mechanisms of deep earthquakes in the Basin and Range and geometrical considerations make it very unlikely that detachment surfaces underlie Yucca Mountain at a shallow level [Carr and others, 1986; W. B. Hamilton, unpublished manuscript entitled "Detachment faulting and tectonic modeling in the Yucca Mountain region, dated 30 June 1994, hereinafter cited as Hamilton, written commun., 1994; C. J. Fridrich, unpublished manuscript entitled "Tectonic evolution of Crater Flat structural basin, Yucca Mountain, Nevada", dated 24 Sept. 1995, hereinafter cited as Fridrich, written commun., 1995].

Yucca Mountain itself is formed by stratiform, gently east-dipping Miocene ash-flow tuffs that are broken by north-trending, west-dipping normal faults [e.g., Scott and Bonk, 1986; Fox and Carr, 1989; Scott, 1990]. The bulk of the tuffs comprising Yucca Mountain has been dated at 12.7 to 12.8 ± 0.3 Ma by the $^{40}Ar/^{39}Ar$ method [Sawyer and others, 1994]. Most of the offset of the

Miocene tuffs along the normal faults is relatively modest, although a few of these faults have been mapped with up to 400 m of offset near the surface [Simonds and others, in press]. Fault dips measured at the surface are typically between 60 and 80 degrees.

Seismic reflection Lines 2 and 3 cross a structural trough that trends northward across the southern Great Basin (fig. 1A). This trough, called the "Amargosa Desert rift zone" by Wright [1989] and the "Kawich-Greenwater rift" by Carr [1990], was first defined on the basis of gravity studies [Healey and Miller, 1965; Healey and others, 1980; U.S. Geological Survey, 1984]. Carr [1990] proposed that this trough represents "a pull-apart at a right-step in the Walker Lane and that the rift was the headwall or breakaway zone for detachment faulting to the west". The structural trough underlies Yucca Mountain and Crater Flat, and its outline has been refined using seismic reflection profiling along Line AV-1 and geological mapping, as well as drill-hole, seismic refraction, electrical, and additional gravity data.

Crater Flat is an elliptical basin bounded on the west by Bare Mountain and on the east by Yucca Mountain (fig. 1A). Gravity and seismic refraction data indicate that the basin fill reaches a thickness of 3 to 4 km [Langenheim, 1995; Mooney and Schapper, 1995]. Three main hypotheses have been proposed for the formation of Crater Flat: (1) caldera or volcano-tectonic development [Snyder and Carr, 1984], (2) detachment faulting [Hamilton, 1988], and (3) graben formation [Fridrich and others, 1994b]. Gravity models consistent with the first two models have been proposed [Snyder and Carr, 1984; Oliver and Fox, 1993; Langenheim, 1995]. More recently, Fridrich [written commun., 1995] has proposed a hybrid origin for Crater Flat structural basin, and he proposed that Crater Flat and Yucca Mountain form a single structural domain.

Stratigraphy

The oldest rocks exposed in the vicinity of seismic Lines 2 and 3 are upper Proterozoic and Paleozoic rocks exposed at Bare Mountain, the Calico Hills, the Striped Hills, and the Specter Range (fig. 1A) [Cornwall and Kleinhampl, 1961; Burchfiel, 1964, 1965; McKay and Williams, 1964; Maldonado, 1985; Monsen and others, 1992] and in the subsurface at UE-25 p#1 [Carr and others, 1986]. The Proterozoic and lower Paleozoic (Cambrian) section consists mostly of clastic and carbonate rocks and is estimated to be at least 2400 m thick at Bare Mountain [Monsen and others, 1992] and over 2800 m thick in the Specter Range [Burchfiel, 1964]. It is likely that the upper Proterozoic and lower Paleozoic sequence rests unconformably on Early Proterozoic crystalline basement rocks at depth in the vicinity of Lines 2 and 3 [Wright and Troxel, 1967].

A sequence of Middle Cambrian through Devonian continental-shelf dolostone and limestone, more than 4000 m thick in the Specter Range [Burchfiel, 1964], was deposited conformably above the upper Proterozoic and lower Cambrian clastic rocks. The thickness of Middle Cambrian (Bonanza King Formation) through Devonian (Eleana Formation) rocks is estimated to be more than 4300 m at Bare Mountain [Monsen and others, 1992]. Structurally

dismembered elements of this sequence are exposed in the hills to the east of Yucca Mountain and are likely to be present below the Cenozoic cover along Lines 2 and 3. The Proterozoic and Paleozoic rocks at Bare Mountain are extensively faulted, both by low-angle thrust faults and high-angle normal faults, and folded at kilometer and outcrop scales [Monsen and others, 1992]. Dips near Steve's Pass are relatively steep, and the Proterozoic/Paleozoic section is locally overturned. Similarly, in the Striped Hills southeast of the eastern end of Line 3, the Paleozoic section has been tilted to nearly vertical and extensively faulted [Sargent and others, 1970; Maldonado, 1985]. In the Calico Hills, the upper-plate Paleozoic rocks about 6 km north of the eastern end of Line 3 are also locally overturned and extensively faulted by low- and high-angle faults [McKay and Williams, 1964].

Yucca Mountain itself consists of a thick sequence of Miocene tuffs and lavas of the ~12.8-12.7 Ma Paintbrush Group, produced at the peak of southwest Nevada volcanic field (SWNVF) eruption [Sawyer and others, 1994]. More than 2200 km^3 of magma was erupted during short episodes within 100 k.y. to form the Topopah Spring and Tiva Canyon Tuffs of the Paintbrush Group. Eruption of these units occurred at a rate identified as the highest during the lifetime of the SWNVF [Sawyer and others, 1994]. The caldera source for the Topopah Spring Tuff is buried and the location uncertain, but the Tiva Canyon Tuff was erupted from the Claim Canyon Caldera [Byers and others, 1976; Sawyer and others, 1994] to the north of present-day Yucca Mountain.

According to Spengler and Fox [1989], "the [Miocene volcanic section at Yucca Mountain] consists chiefly of rhyolitic ash-flow tuffs intercalated with thin beds of volcaniclastic rock. The ash-flow tuffs consist of an alternating sequence of nonwelded to densely welded rock, composed primarily of ash and a poorly sorted mixture of pumice, lithic clasts, and phenocrysts. Variability in initial welding compaction is considered the principal factor controlling the distribution of several physical and mechanical properties particularly at shallow depth. Dry bulk density and matrix porosity of the rock mass correlate closely with field estimates of the degree of welding, despite vertical variability in overburden pressure, growth of vapor-phase minerals, and secondary alteration."

The volcanic section at Yucca Mountain forms a wedge-shaped sequence 3.5 km thick at its northern end and progressively thinner to the south [Spengler and Fox, 1989]. The Paintbrush Group is underlain by the Crater Flat Group, comprised of the older Prow Pass, Bullfrog, and Tram Tuffs estimated to total 880 km^3 in erupted magma [Sawyer and others, 1994]. The Bullfrog Tuff, dated at 13.25 Ma, is thought to originate from a caldera north of Yucca Mountain, but the origin of the two other tuffs is uncertain [Sawyer and others, 1994]. The Crater Flat Group, like the Paintbrush Group, consists of nonwelded to densely welded tuffs, with units ranging from lithic-poor to lithic-rich [e.g., Spengler and others, 1981; Scott and Castellanos, 1984]. Pronounced variations in rock density, and by inference, seismic velocity, within the Prow

Pass and Bullfrog Tuffs [Nelson and others, 1991] are presumed to produce seismic reflections imaged in our lines.

The Miocene tuffaceous sequence is broken by a series of high-angle north-trending normal faults into a series of intact but fault-bounded blocks [Scott and Bonk, 1984; Spengler and Fox, 1989]. The geologic complexity of this sequence and resultant scattering of seismic energy have limited earlier attempts to acquire high-quality seismic reflection data [McGovern and Turner, 1983]. Megascopic voids (lithophysal cavities) which comprise up to 30 percent of some parts of the Topopah Spring Tuff [Spengler and Fox, 1989] formed during early stages of crystallization of the ash-flow tuffs and may influence physical properties of the rock and its resultant seismic response.

Cenozoic nonmarine sedimentary rocks and volcanic rocks rest unconformably or in fault contact on the upper Proterozoic and Paleozoic continental-shelf rocks in the mountains surrounding the Amargosa Desert. Oligocene sedimentary rocks [Hinrichs, 1968; Maldonado, 1985], which have been erroneously correlated with the Miocene Horse Spring Formation [Barnes and others, 1982], are the oldest Tertiary rocks known in the area. Alluvial, fluvial, and lacustrine deposits with sparse beds of volcanic ash form the lower and middle Miocene section in the eastern Amargosa Desert. Within the Nevada Test Site these rocks have been informally designated as the rocks of the Pavits Spring Formation [e.g., Barnes and others, 1982]. Locally, massive tongues of monolithologic carbonate breccia derived from lower Paleozoic strata are intercalated in Tertiary basin deposits [Swadley and Parrish, 1988; Swadley and Carr, 1989]. In the vicinity of Timber Mountain, about 25 km north of Yucca Mountain, Miocene sedimentary deposits intertongue with coeval ash-flow tuff units erupted from calderas [Barnes and others, 1982].

DATA ACQUISITION PARAMETER TESTING

Three days of field testing were conducted to determine optimal parameters for the acquisition of seismic reflection data along Lines 2 and 3. This testing was performed in Crater Flat between Stations 673 and 833 along Line 2, northeast of well USW VH-1 (fig. 1B). This test location was chosen to minimize logistical problems as well as to attempt to sample conditions close to Yucca Mountain and Crater Flat during the testing. Reflections observed during the parameter testing, such as the event at 0.8 s twtt along this part of the line (fig. 10), permitted focusing of the acquisition parameters. The testing was conducted along a fairly straight and gently inclined gravel road.

During parameter (noise) testing, three individual receiver arrays (lines in I/O System Two nomenclature), each containing a different geophone-group array pattern, were compared side-to-side. Each array (line) was 4 km long and consisted of 160 individual group arrays spaced at

82.5-ft (25-m) intervals. The first geophone-group array pattern consisted of 12 geophones placed within a circle of about 1-m radius (often called a potted array because it acts as a point receiver). Another geophone-group array pattern was 165 ft (50 m) long and consisted of a nonlinear array of 24 geophones weighted on the pin flag as was used for Line AV-1 (fig. 2A) [Brocher and others, 1990]. The last geophone-group array pattern consisted of 24 geophones inline in a linear array 165 ft (50 m) long (fig. 2B). All geophones were 10-Hz Geospace Model 20D.

The large number of channels (481) used in parameter testing required about a day and a half to deploy and retrieve. A long test spread, however, was considered necessary due to the lack of existing regional reflection data near Yucca Mountain and consequent uncertainty about data quality and where reflections might occur in space and time. Although testing made clear that either 165-ft (50-m) array would provide noise cancellation superior to the potted geophone pattern, there was little difference in the output of the two 165-ft (50-m) patterns (figs. 3 and 4). We therefore chose the 165-ft (50-m) linear geophone pattern (fig. 2B) for collection of Lines 2 and 3. All geophones were buried along the test line and Lines 2 and 3 except for a few, limited stretches of the lines.

First-break velocities along the test line were between 2500 and 5000 ft/s for a shallow refractor, and between 7000 and 10,000 ft/s for a deeper refractor. The ground roll had velocities between 2000 and 2500 ft/s and had a predominant frequency of about 10 Hz (fig. 3A). The ground roll was similar to that encountered along Line AV-1 [Brocher and others, 1990]. We attempted to attenuate the ground roll using the 165-ft (50-m) geophone pattern described above.

Several vibrator source parameters were compared during the parameter (noise) testing. All together, 27 vibrator records were collected to compare different vibrator sweep frequencies, sweep lengths, number of vibrator sweeps, and geometry of vibrator patterns (Table 1; Appendix 4). Comparisons of vibrator parameters were made in five different locations along Line 2 between Stations 652 and 834, although more than half of the records were obtained at Station 752. Sweep frequencies between 8 and 120 Hz were compared in three different locations (Tests 1 and 2, 10 and 11, and Line 2 tests 4 and 5 on Table 1). Sweep lengths of 6, 8, 12, 18 and 24 s were compared at Station 752 (Tests 3 to 5, 20 to 21 on Table 1). The number of sweeps was tested at Station 672, where records were obtained with six, eight, and ten sweeps (Tests 12 to 14 on Table 1).

Three main types of vibrator patterns were compared. One was a bumper-to-bumper vibrator array without move-up between sweeps (a stacked pattern). The second vibrator pattern consisted of the four-vibrator 231-ft (70-m) pattern used to acquire Line AV-1, modified here to be 225 ft (69 m) long (see fig. 2F). The third vibrator pattern was a four-vibrator 165-ft (50-m) pattern tested by Brocher and others [1990] in the Amargosa Desert (fig. 2G). Vibrator patterns were compared in Tests 6 and 7, 8 and 9, 15 and 16, and 22 to 24 (Table 1). A halt in the acquisition of Line 2, caused by problems in getting the receiver spread deployed, permitted further

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testing of vibrator patterns. Tests 1 to 3 on Line 2 compared different 165-ft (50-m) and 195-ft (59-m) vibrator patterns (figs. 2H and 2I). These three patterns on Line 2 yielded very similar records, and, in turn, these records were very similar to those obtained using the production vibrator pattern. These tests suggest that earlier differences noted in records from the 165-ft (50-m) vibrator pattern with only five move-ups (fig. 2G) and the 225-ft (69-m) vibrator pattern with 11 move-ups (fig. 2F) may have resulted primarily from the smaller number of different source array points rather than from the total length of the pattern.

Figure 3 compares records obtained using 10 to 50 Hz sweeps for two different vibrator patterns at station (St.) 752, in the middle of the noise test spread. Figure 3A shows the record obtained using vibrators without move-up. Figure 3B shows the record obtained using the 225-ft (69-m) pattern used to acquire Lines 2 and 3 (fig. 2F). In both Figures 3A and 3B, we show the data recorded by the 165-ft (50-m) weighted inline geophone group array, the potted geophone array, and the 165-ft (50-m) linear geophone group array. The potted geophone group array (fig. 3A) shows the coherent noise which would be generated without either a vibrator or geophone group array. Conversely, the linear group array in Figure 3B shows how the arrays used to acquire Lines 2 and 3 have attenuated the surface wave energy produced by the source.

Figure 4 compares records obtained using 10 to 50 Hz sweeps for two different vibrator patterns at St. 652, about 0.5 km off the end of the spread. Figure 4A shows the record obtained using the 225-ft (69-m) pattern used to acquire Lines 2 and 3. Figure 4B shows the record obtained by a 165-ft (50-m) pattern with move-up between every other sweep (fig. 2G). Note a minor improvement in the quality between Figure 4B and Figure 4A of the reflection observed at about 1.5 s at far offsets.

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Table 1. Data Acquisition Parameter Tests

Test #	No. Sweeps	Sweep Length (sec)	Sweep Frequency*	Vibrator Pattern
At Station 752:				
1	12	12	8-40 Hz	Bumper to bumper pattern with no move-up
2	12	12	12-80 Hz	Bumper to bumper pattern with no move-up
3	12	6	10-50 Hz	Bumper to bumper pattern with no move-up
4	12	8	10-50 Hz	Bumper to bumper pattern with no move-up
5	12	12	10-50 Hz	Bumper to bumper pattern with no move-up
6	12	12	10-50 Hz	165-ft pattern with 7.2-ft move-ups. 2 sweeps at each location and 5 move-ups total.
7	12	12	10-50 Hz	225-ft pattern with 8-ft move-ups. 11 move-ups total
At Station 672:				
8	12	12	10-50 Hz	225-ft pattern with 8-ft move-ups. 11 move-ups total
9	12	12	10-50 Hz	165-ft pattern with 7.2-ft move-ups. 2 sweeps at each location and 5 move-ups total
10	12	12	8-40 Hz	Bumper to bumper pattern with no move-up
11	12	12	12-80 Hz	Bumper to bumper pattern with no move-up
12	6	12	10-50 Hz	Bumper to bumper pattern with no move-up
13	8	12	10-50 Hz	Bumper to bumper pattern with no move-up
14	10	12	10-50 Hz	Bumper to bumper pattern with no move-up
At Station 652:				
15	12	12	10-50 Hz	225-ft pattern with 8-ft move-ups. 11 move-ups total
16	12	12	10-50 Hz	165-ft pattern with 7.2-ft move-ups. 2 sweeps at each location and 5 move-ups total
At Station 752:				
17	Poulter Charge			40 lbs over 165 ft
18	Poulter Charge			40 lbs over 82.5 ft
19	12	12	12-70 Hz	165-ft pattern with 7.2-ft move-ups. 2 sweeps at each location and 5 move-ups total
20	12	18	10-50 Hz	Bumper to bumper pattern with no move-up
21	12	24	10-50 Hz	Bumper to bumper pattern with no move-up
At Station 834:				
22	12	12	10-50 Hz	225-ft pattern with 8-ft move-ups. 11 move-ups total
23	12	12	10-50 Hz	165-ft pattern with 7.2-ft move-ups. 2 sweeps at each location and 5 move-ups total
24	12	12	10-50 Hz	Bumper to bumper pattern with no move-up
At Station 757 - Test during Line 2 - 31 October 1994:				
1	12	12	10-50 Hz	195-ft pattern with 7.5-ft move-ups. 11 move-ups total (production parameters).
2	12	12	10-50 Hz	165-ft pattern with 4-ft move-ups with a total move-up 44 ft. 11 move-ups total (production parameters).
3	12	12	10-50 Hz	165-ft pattern with 7.5-ft move-ups with a total move 82.5 ft. 11 move-ups total (production parameters).
4	12	12	12-70 Hz	165-ft pattern with 7.5-ft move-ups. 11 move-ups total with a total move-up of 82.5 ft.
5	12	12	12-120 Hz	165-ft pattern with 7.5-ft move-ups. 11 move-ups total with a total move-up of 82.5 ft.

*Four vibrators, 8-second listen used for all vibrator tests; all patterns centered on the flag.

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We chose a 10- to 50-Hz sweep for vibrator acquisition along Lines 2 and 3 after comparing the data resulting from these vibrator tests, plotted as unfiltered and bandpass-filtered common shot records, as well as comparing spectra of these data. Because of the relatively shallow target depth of study, we sought to use high frequencies if possible. Unfortunately, above 50 Hz there appeared to be little signal-generated reflection energy, although there was significant ambient and source-generated noise above this frequency. Based on our field comparisons, we also selected a 12-s-long sweep, 12 sweeps per vibrator pattern, 8-ft (2.5-m) vibrator move-ups, and a total vibrator pattern length of 225 ft (68.6 m; fig. 2F). Throughout our work we used four Mertz Model 18 buggy-mounted vibrators with Pelton Advanced 2 Release 5.0 electronics (see Appendix 2). During vibrator testing, data were recorded as summed and correlated to allow real-time plotting of correlated records in the recording truck. This choice allowed rapid decisions about the choice of vibrator parameters. During acquisition of Lines 2 and 3, however, vibrator data were recorded summed but uncorrelated and plotted as uncorrelated records in the recording truck.

Two different Poulter charges (surface explosive charges [Poulter, 1950]) were compared to determine the optimal pattern length (Tests 17 and 18 on Table 1). Each Poulter charge consisted of 40 lbs (18.2 kg) of Surf-A-Seis explosive distributed over eight wooden stakes, each 6 ft (1.8 m) tall. Both patterns were linear and centered on the station flag: one pattern was distributed over 82.5 ft (25 m) and the other over 165 ft (50 m; fig. 2C and 2D). We selected the shorter Poulter pattern because it provided better suppression of the large-amplitude air blast arrival than did the longer Poulter pattern.

Ideal weather conditions prevailed during the parameter testing. Wind speeds were low and temperatures were warm. Wind speeds were recorded at several locations close to Lines 2 and 3 during our field work, including sites at Yucca Mountain, Coyote Wash, Alice Hill, Knothead Gap, and NTS-60 [Tim Moran, DOE, personal communication, 1994]. The station at Yucca Mountain is located on the crest of Yucca Mountain (Nevada State Coordinates are 558,844E; 766,356N) about 2.3 km north of Lines 2 and 3. During parameter testing wind speeds at the Yucca Mountain station were generally less than 4 m/s (8.9 mi/hr; fig. 5a). Station NTS-60 (Nevada State Coordinates 569,126E; 761,795N) was located about 290 m east of St. 1133 on Line 2. The station at Knothead Gap (Nevada State Coordinates 570,344E; 756,538N) was located within meters of St. 322 on Line 3. Figure 5 presents a plot of wind speeds, in m/s, recorded at Yucca Mountain, NTS-60, and Knothead Gap during our seismic profiling. Values in excess of 12 m/s signify an absence of wind speed data for that time.

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ACQUISITION OF SEISMIC REFLECTION LINES 2 AND 3

This section presents a brief narrative describing the acquisition of Lines 2 and 3. Problems encountered during the acquisition are recounted as well as the means by which they were resolved. Those readers more interested in the actual data may skip on to the next sections.

Line 2

Data acquisition along Line 2, totaling 26 km (16.1 mi), began in the Amargosa Desert (fig. 1) on October 27, 1994, using vibrators (see observer's log in Appendix 5). Line 2 trended northeast from the start of line (SOL) at Station 101, crossed State Highway 95 at station 235, and ran through Steve's Pass at Station 338 before it turned and trended across country between Stations 343 and 646 (fig. 1). The line deviated slightly to the south around the southern end of Red Cone to avoid the lava flows there. Northeast of Red Cone the line straightened and intersected well USW VH-1 near Station 646 (see Table 2). From Station 945 to the end of line (EOL) at Station 1133, the line ran across country over Yucca Mountain, passing near wells USW WT-7, USW UZ-6, USW SD-7, USW WT-2, USW UZ 7-A, USW H-4, and UE-25 UZ-16. These well ties are detailed in Table 2.

The observer's log (Appendix 5) identifies sources of ambient noise along the line. A large noise source was State Highway 95 on the southwest end of the line (Station 235). Other large noise sources were found in the vicinity of Yucca Mountain with drilling activities at a few sites, including USW SD-7, and at Exile Hill, where work on and with the tunnel boring machine (TBM) was in progress.

Acquisition parameters for Line 2 are provided in Table 3. The vibrator source array was rolled into a spread maintaining 240 channels in front of the vibrator sources until it reached the middle of a symmetric split spread with 240 channels on each side of the source. At that point the symmetric split spread was rolled along. No gap was used between the source and receivers. The group interval was 25 m (82.5 ft). Vibrator source points were spaced at 330-ft (100.6-m) intervals between Stations 101 and 945, providing nominal 60-fold data. Vibrator profiling was completed on November 2, 1994.

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Table 2. Well Ties to Lines 2 and 3

Well	Northing	Easting	Line, Sta. No.	Distance (ft)	Azimuth*
USW VH-1	743355.5	533625.9	2, 646	130	SE, 153°
USW WT-7	755569.8	553891.3	2, 938	150	NW, 309°
USW UZ-6	759731	558325	2, 1009	1112	NNW, 338°
USW SD-7	758949.89	561240.3	2, 1036	790	NNW, 338°
USW WT-2	760661	561924	2, 1054	620	NNW, 337°
USW UZ 7-A	760692.74	562269.8	2, 1058	530	NNW, 337°
USW H-4	761643.6	563911.1	2, 1079	1050	N, 350°
UE-25 UZ-16	760535	564857	2, 1088	215	S, 170°
USW H-6	763298.9	554074.9	3, 101	67	N, 004°
USW UZ-6	759731	558325	3, 167	150	S, 199°
USW SD-7	758949.89	561240.28	3, 204	60	NE, 45°
USW WT-2	760661	561924	3, 206	1870	N, 19°
UE-25 p#1	756171.2	571484.5	3, 337	9	S, 197°

*Azimuth from seismic line to well, measured clockwise from North.

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Table 3. Data Acquisition Parameters for Line 2

Parameter	Description
Recording Instrumentation	I/O System Two with twisted pair cables and 24-bit recording
Vibrator Array	Four Mertz Model 18 buggy vibrators, each providing a peak force of 45,000 lbs with force control and phase loop locking
Vibrator Electronics	Pelton Advance 2 Release 5.0
Vibrator Pattern	Four vibrators in a 12-element pattern, with a pad spacing of 47.9 ft and an 8-ft move-up between sweeps for a total pattern length of 225 ft
Sweep Frequency	10 to 50 Hz upsweep with a 0.2 s taper
Sweep Length	12 seconds
Listen Time	8 seconds
Record Length	20 seconds
Sample Rate	2 milliseconds
Field Filters	Low-cut 3.0 Hz @ 12 db Slope; High-cut (anti-alias) 135 Hz @190 db slope; Notch Out
Number of Sweeps per VP	12
VP Interval	330 ft (~100 m; every 4th flag)
Receiver group spacing	82.5 ft (~25 m)
Receiver pattern	Linear inline pattern of 24 geophones over 165 ft centered on flag
Geophone Model	Geospace 20D, 10 Hz
Receiver spread	481 channel, symmetric split spread, 240 channels each a side of source, ~6 km maximum offset on each side of source, roll into and roll out of full 481 channels on end of line
CDP fold (vibrator)	Nominal 60 at full fold
Recording format	SEG-D at 6250 BPI on 9-track tape; vibrator data recorded summed but uncorrelated
Poulter Charge Pattern	40 lbs of SURF-A-SEIS explosive over 82.5 ft on 8 stakes with 5 lbs/stake centered on flag. Each stake 6 ft high.
Poulter Charge Spacing	165 ft (~50 m; every 2 flags)
Poulter Record Length	8 seconds
CDP fold (Poulter)	94 maximum fold
Explosive Shot hole Spacing	80 stations (flags) ~2 km
Explosive Shot hole Depths	100 ft for 100 lb shots, 200 ft for 200 lb shots

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The heart of the recording system was the I/O System II, a digital telemetry-based system, whose primary means for quality control is look-ahead testing of the RSX units deployed along the cable. These RSX units control the signals from three geophone group arrays on each side of the RSX unit, conditioning and digitizing the signals prior to telemetering the data to the recording truck. The look-ahead tests performed on each RSX unit prior to its use are provided in Table 4. This table provides a list of both those look-ahead tests done on a daily basis to verify satisfactory system performance prior to data acquisition, as well as those look-ahead tests that were continuously monitored during data acquisition. The I/O System II, like many current telemetry-based recording units, offers a number of real-time data-quality monitoring functions and automatically halted the acquisition of data for major errors. Over 81 RSX units were in use at any time for the 481-channel spread used for Line 2. Summed but uncorrelated data were digitally recorded at a 2-msec sample interval on 6250 BPI magnetic tapes in SEG-D format [Barry and others, 1975]. The listen time for the vibrator data was 8 s.

A 2- to 8-fold seismic image of the lower crust (5 to 10 s) along Line 2 was obtained using deep shot holes. As the spread rolled through the line, 100- and 200-lbs (45- and 91-kg) charges were fired in shot holes at 2-km intervals along the line. These Vibragel charges, manufactured by DYNO, were loaded into 100- and 200-ft (30- and 61-m) shot holes and tamped with Wyoming bentonite and drilling cuttings. The holes were pre-drilled and cased with 4-in (10-cm) outer-diameter PVC casing. No tamping was blown out, and there was no surface disturbance at any shot hole. Charge lengths were 88 ft (27 m) for the 200-lbs (91-kg) shots and 44 ft (13 m) for the 100-lbs (45-kg) shots. Each shot was recorded by 481 channels for 20 seconds.

Details of the shot holes used for Lines 2 and 3 are provided in Tables 5 to 8. Table 5 gives the location of each shot hole, the depth to the bottom of the PVC casing (and consequently the depth to the bottom of the charge), the charge weight in lbs, the uphole time of the shot, the date, and the approximate local time of the shot. These local shot times are considered accurate to about 10 minutes. The number of the shooting system, shooter(s), and wind conditions for each shot are given in Table 6. Unfortunately, because of the need to maintain data production many of these shots were recorded in gusty and strong wind conditions. Many of the shot hole locations were staked nearly two years prior to the survey, in order to obtain the necessary permits. A comparison of the design (staked) shot hole location versus the final, actual shot hole location is presented in Table 7. These locations were generally very close (within 100 m), apart from shot point 311, and shot point 300, which was not resurveyed. Finally, Table 8 summarizes lithologies encountered in some of the shot holes. Most of the holes encountered a single lithology, although a number of lithologies were encountered in shot points 3 through 7 and 201. Shot hole lithologies are unavailable for the holes not listed in Table 8.

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Table 4. Look-Ahead Tests (LATs) of the RSX Units

<u>Daily</u>
1. Short Equivalent Input Noise Test (2-s records)
2. Filtered Pulse Test (Limit <7.5% RMS error from Average Pulse)
3. Dynamic Range Test (0 db, 72 db, 84 db, Fx Gain)
4. Harmonic Distortion Test Class I (Limit <0.02%)
5. Seis Channel Gain Calibration (Limits 0.96-1.10)
6. Oscillator Calibration (RMS Limit 6.85 v ± 5%; THD Limit <0.01%)
7. A/D Converter Calibration (Gain Limit 0.816-1.016; Channel Offsets Limit ± 0.138 v)
<u>Continuous Mode LATs</u>
1. Short Equivalent Input Noise Test (2 sec records)
2. Filtered Pulse Test (Limit <7.5% RMS error from Average Pulse)
3. Dynamic Range Test (0 db, 72 db, 84 db, Fx Gain)
4. Harmonic Distortion Test Class I (Limit <0.02%)
5. RSX Calibration

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Table 5. Shot hole Information for Lines 2 and 3

SP #	Location: Lat. (°N) (Dg., Mn., Sc.)	Long. (°W) (Dg., Mn., Sc.)	Nev. State Coord. X (ft)	Y (ft)	Z (ft)	Sta. #	PVC Depth (ft)	Charge Size (lbs)	Uphole Time (msec)	1994 Date	Approx. Local Time HrMin
1	36 43 13.86	116 40 18.20	498518	717221	2663	101	201.3	200	41	10/28	1338
3	36 43 59.36	116 39 23.29	502988	721822	2671	178	202.4	200	37	10/28	1423
5	36 44 46.34	116 38 29.43	507371	726574	2736	258	200.0	200	31	10/28	1533
7	36 45 29.12	116 37 33.69	511905	730902	2953	338	198.0	200	26	10/28	1631
9	36 45 58.91	116 36 30.86	517016	733917	2939	410	201.4	200	22	10/29	1401
11	36 46 31.42	116 35 21.07	522691	737209	2999	490	202.3	200	39	10/29	1426
13	36 47 04.03	116 34 11.38	528358	740511	3062	573	201.9	200	41	10/30	1339
201	36 47 36.64	116 33 01.64	534026	743815	3173	653	206.4	200	27	10/30	1658
203	36 48 08.24	116 31 50.58	539801	747018	3364	733	200.0	200	34	10/30	1726
205	36 48 39.50	116 30 42.54	545329	750187	3574	811	191.8	200	30	11/01	1556
205A	36 48 40.72	116 30 41.11	545445	750311	3574	813	191.7	200	37	11/01	1605
205B	36 48 41.87	116 30 39.73	545558	750427	3575	817	191.4	200	38	11/01	1610
207	36 49 15.70	116 29 33.16	550965	753858	3783	895	188.7	200	33	11/02	1153
208.5A	36 49 52.19	116 28 21.35	556795	757559	4249	980	99.9	100	19	11/02	1732
208.5B	36 49 52.21	116 28 21.70	556767	757561	4243	981	100.2	100	17	11/02	1743
211A	36 50 22.48	116 26 58.06	563560	760637	4109	1072	100.0	100	20	11/03	1436
211B	36 50 22.82	116 26 58.50	563523	760671	4113	1072	99.5	100	24	11/03	1434
300*	36 51 22.66	116 32 08.87	538287	766676	----	100	201.7	100	38	11/11	0943
302A	36 50 37.99	116 28 35.24	555657	762188	4162	124	100.0	50	25	11/11	0850
302B	36 50 37.56	116 28 34.88	555687	762145	4257	125	100.0	100	18	11/11	0853
305A	36 49 55.38	116 27 01.74	563266	757895	4153	232	100.0	100	12	11/09	1045
305B	36 49 54.95	116 27 01.45	563290	757852	4150	232	100.0	100	12	11/09	1051
307	36 49 38.56	116 25 27.33	570946	756213	3662	330	200.6	200	34	11/11	1016
311	36 49 27.27	116 24 02.44	577850	755090	3357	416	201.5	200	34	11/11	0854

*Latitude and Longitude of SP 300 are taken from GPS coordinates of Shot hole Stakes by Michael J. Moses, USGS, 10/30/92. Estimated Northing and Easting for SP 300 are from a Letter dated 8 Apr. 1993 from C. Thomas Statton, TRW, to Mark Tynan, DOE, YMSCPO, reference LV.SC.JDA.4/94-099. The location of SP 300 was not resurveyed by NGA surveyors.

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Table 6. Shot hole Shooting Systems, Shooters, and Wind Conditions

SP #	Location X (ft)	Y (ft)	Z (ft)	Shooting System	Shooter(s)	Wind Conditions
Line 2						
1	498518	717221	2663	M-1	Jason Clark/Dan Malberg	Light
3	502988	721822	2671	M-1	Jason Clark/Dan Malberg	Slightly higher winds
5	507371	726574	2736	M-1	Jason Clark/Kim Wegemeyer	Strong wind from south
7	511905	730902	2953	M-1	Jason Clark/Kim Wegemeyer	Winds less strong than for SP 5
9	517016	733917	2939	M-1	Dan Malberg	Windy
11	522691	737209	2999	M-1	Dan Malberg	Windy
13	528358	740511	3062	M-1	Dan Malberg	Variable, gusty winds
201	534026	743815	3173	M-1	Dan Malberg	Very light winds
203	539801	747018	3364	M-1	Dan Malberg	Calm to light winds
205	545329	750187	3574	M-1	Dan Malberg	Breezy
205A	545445	750311	3574	M-1	Dan Malberg	Breezy
205B	545558	750427	3575	M-1	Dan Malberg	Breezy
207	550965	753858	3783	M-1	Randy Stamey/Oliver Amend	Variable, gusty winds
208.5A	556795	757559	4249	M-1	Randy Stamey/Oliver Amend	Variable, gusty winds
208.5B	556767	757561	4243	M-1	Randy Stamey/Oliver Amend	Variable, gusty winds
211A	563560	760637	4109	M-1	Randy Stamey/Oliver Amend	Strong winds
211B	563523	760671	4113	M-1	Randy Stamey/Oliver Amend	Strong winds
Line 3						
300#	538287	766676	----	PT400	Greg Brooks/George Berala	Calm to very light
302A	555657	762188	4162	PT400	Greg Brooks/George Berala	Calm to light
302B	555687	762145	4257	PT400	Greg Brooks/George Berala	Calm to light
305A	563266	757895	4153	M-1	Randy Stamey/Oliver Amend	Windy
305B	563290	757852	4150	M-1	Randy Stamey/Oliver Amend	Windy
307	570946	756213	3662	HT600	Oliver Amend/Randy Fortin	Very light
311	577850	755090	3357	PT400	Randy Fortin/Greg Brooks	Light

#Estimated Northing and Easting for SP 300 are from a Letter dated 8 Apr. 1993 from C. Thomas Statton, TRW, to Mark Tynan, DOE, YMSCPO, reference LV.SC.JDA.4/94-099. The location of SP 300 was not resurveyed by NGA surveyors.

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Table 7. Comparison of Designed and Actual Shot hole Locations for Lines 2 and 3

SP #	Actual Location (by Extreme Survey) Lat. (°N) (D..M..S.)	Actual Location (by Extreme Survey) Long.(°W) (D..M..S.)	Design Location (by GPS)# Lat. (°N) D..M..S.)	Design Location (by GPS)# Long.(°W) (D..M..S.)	Actual Location (by Extreme Survey) X (ft)	Y (ft)	Z (ft)	Design Location (Estimated)* X (ft)	Y (ft)	Z (ft)
Line 2										
201	36 47 36.64	116 33 01.64	36 47 37.56	116 33 01.48	534026	743815	3173	534040	743907	
203	36 48 08.24	116 31 50.58	36 48 09.06	116 31 50.68	539801	747018	3364	539794	747101	
205	36 48 39.50	116 30 42.54	36 48 42.36	116 30 41.38	545329	750187	3574	545424	750476	
205A	36 48 40.72	116 30 41.11	36 48 42.36	116 30 41.38	545445	750311	3574	545424	750476	
205B	36 48 41.87	116 30 39.73	36 48 42.36	116 30 41.38	545558	750427	3575	545424	750476	
207	36 49 15.70	116 29 33.16	36 49 16.76	116 29 32.58	550965	753858	3783	551012	753965	
208.5A	36 49 52.19	116 28 21.35	Not Measured		556795	757559	4249	556582	757516	4228
208.5B	36 49 52.21	116 28 21.70	Not Measured		556767	757561	4243	556582	757516	4228
211A	36 50 22.48	116 26 58.06	36 50 20.10	116 26 55.31	563560	760637	4109	563477	760540	4314
211B	36 50 22.82	116 26 58.50	36 50 20.10	116 26 55.31	563523	760671	4113	563477	760540	4314
Line 3										
300	Not Measured		36 51 22.66	116 32 08.88	Not Measured			538287	766676	---
302A	36 50 37.99	116 28 35.24	36 50 39.36	116 28 34.08	555657	762188	4162	555751	762327	
302B	36 50 37.56	116 28 34.88	36 50 39.36	116 28 34.08	555687	762145	4257	555751	762327	
305A	36 49 55.38	116 27 01.74	36 49 54.40	116 27 04.10	563266	757895	4153	563203	757704	5162
305B	36 49 54.95	116 27 01.45	36 49 54.40	116 27 04.10	563290	757852	4150	563203	757704	5162
307	36 49 38.56	116 25 27.33	36 49 27.50	116 25 27.50	570946	756213	3662	570820	756277	4101
311	36 49 27.27	116 24 02.44	Not Measured		577850	755090	3357	578238	754965	3522

#Latitude and Longitudes taken from GPS coordinates by Michael J. Moses, USGS, 10/30/92.
*Estimated Northing and Easting for SP 300 are from a Letter dated 8 Apr. 1993 from C. Thomas Statton, TRW, to Mark Tynan, DOE, YMSCPO, reference LV.SC.JDA.4/94-099. The location of SP 300 was not resurveyed by NGA surveyors.

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Table 8. Shot hole Lithologies for Lines 2 and 3

SP #	Location X (ft)	Y (ft)	Z (ft)	Hole Depth (ft)*	Lithology*
Line 2					
1	498518	717221	2663	0-201	Sand and gravels
3	502988	721822	2671	0-130	Sand and gravels
				130-202	Volcanic tuff
5	507371	726574	2736	0-68	Sand and gravels
				68-110	White Powder
				110-200	Pre-Rainier Mesa tuffaceous rocks
7	511905	730902	2953	0-25	Sand, gravels and Pre-Rainier Mesa tuffaceous rocks
				25-198	Pre-Rainier Mesa tuffaceous rocks
11	522691	737209	2999	0-202	Sands and gravel, unconsolidated rock
13	528358	740511	3062	0-202	Sands and gravel
201	534026	743815	3173	0-40	Sands and gravel
				40-80	Hardpan-Tuff?
				80-145	Tuff
				145-207	Sand and gravel
203	539801	747018	3364	0-171	Sand and gravel
205	545329	750187	3574	95-192	Gravels and cobbles
205A	545445	750311	3574	0-192	Gravels, cobbles, boulders, sand
205B	545558	750427	3575	0-191	Sand, gravel, cobbles, boulders
207	550965	753858	3783	0-145	Sand, gravel, cobbles
Line 3					
300#	538287	766676	-----	0-202	Sand and gravel

*From Drilling Reports, dated August to October, 1994.
#Estimated Northing and Easting for SP 300 are from a Letter dated 8 Apr. 1993 from C. Thomas Statton, TRW, to Mark Tynan, DOE, YMSCPO, reference LV.SCJDA.4/94-099. The location of SP 300 was not resurveyed by NGA surveyors.

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Vibrator production was hampered by the difficulty in deploying the receiver spread up and over Yucca Mountain. Some delay was also introduced by the late arrival of a helicopter to ferry equipment across Yucca Mountain. On October 31 this delay allowed the crew to perform some maintenance on the vibrator trucks and also to perform a series of five additional vibrator tests described in Table 1. High-frequency sweeps were tested as well as vibrator patterns slightly shorter than those used for the production sweep. These tests indicated little difference in record quality for the different vibrator patterns and suggested that little useful additional information could be gathered using higher-frequency sweeps.

Poulter-charge sources were used on Line 2 over the rugged topography of Yucca Mountain between Stations 941 and 1133. The Poulter charges were spaced at 165-ft (50-m) intervals along this line, yielding a maximum fold of 94. Weather conditions during the acquisition of the Poulter charge data were variable; wind speeds on Yucca Mountain exceeded 10 m/s (22 mi/hr) on November 2 and 3 (fig. 5B), degrading the data. During these windy conditions, it was not possible to trace the first arrivals to offsets of 6 km. Lower wind speeds on Yucca Mountain for November 4, between 2 and 4 m/s (fig. 5B), resulted in much less noisy Poulter-charge data than those data acquired on November 2 and 3.

Weather conditions were mixed during data collection along Line 2. In general, however, the weather turned progressively cooler and windier during the acquisition of Line 2 than it had been during noise testing. Figure 5B shows that wind speeds were generally between 2 and 6 m/s (4.4 and 13.4 mi/hr) at Yucca Mountain, but windier conditions were encountered near the completion of Line 2 when winds exceeded 10 m/s (22 mi/hr). Wind speeds at station NTS-60, near the northeast end of Line 2, generally recorded lower wind speeds than did the station at Yucca Mountain. Except for November 2 and 3, wind speeds at NTS-60 during the acquisition of Line 2 were generally between 1 and 4 m/s (2.2 and 8.9 mi/hr; fig. 5D).

During acquisition of the northern end of Line 2, operations of the tunnel-boring machine at Exile Hill and drilling operations at USW SD-7 were shut down to minimize seismic noise in the data.

Line 3

Line 3, 11 km (6.9 mi) long, trended in an easterly direction from SOL at Station 101 near well USW H-6 in Solitario Canyon (fig. 1). The line utilized a few short sections of existing roads (Stations 101 to 126, 164 to 232, and 311 to 338) but generally was acquired cross country. Due to the rugged topography along the line, three different source types were utilized: vibrators along roads, Poulter charges in very rugged segments up and across Yucca Mountain, and a pattern of shallow charges (miniholes) in off-road segments of the line over Fran Ridge. The line was designed to tie to Line 2 and to well UE-25 p#1 but also passed near wells USW H-6, USW UZ-

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6, USW WT-2, and USW SD-7 (Table 2). During field operations the line was lengthened eastward two miles, adding Stations 418 to 541, to extend the line across Fortymile Wash and into Jackass Flats (fig. 1). Details of the acquisition and ambient noise sources along Line 3 are provided in the observer's log for this line (given in Appendix 6).

Parameters used to acquire Line 3 are listed in Table 9. Acquisition of vibrator data on the line began November 5 and was completed November 9. Acquisition of Poulter charge data on Line 3 started November 6. Data acquisition along Line 3 was hindered by the slow rate of drilling of the minihole patterns between Stations 331 and 439. Each minihole pattern consisted of five holes spaced over 80 ft (24 m), each 10 ft (3 m) deep and containing 2 lbs (0.9 kg) of Unimax explosive capped with a single fuse (fig. 2C). Drilling of the minihole patterns, using a person-portable drilling rig powered by compressed air, began October 27 and ended November 8. Acquisition of data along Line 3 was maintained by drilling miniholes during the day and acquiring vibrator data at night after the minihole drilling ceased for the day.

Wind conditions were variable during the acquisition of Line 3 (figs. 5C and 5E). From November 5 to November 8, winds at the Yucca Mountain station on the crest of Yucca Mountain were typically between 2 and 6 m/s (4.4 to 13.4 mi/hr). Wind speeds recorded at Knothead Gap (St. 322) were significantly lower, in the range of 1 to 4 m/s (2.2 to 8.9 mi/hr; fig. 5E). November 9 was stormy at both Yucca Mountain crest and Knothead Gap, with gusty winds in excess of 8 m/s (17.9 mi/hr). High winds (up to 10 m/s or 22 mi/hour) and rain precluded data acquisition on the following day, November 10 (fig. 5C). Line 3 was completed on November 11 when much of the Poulter-charge and all of the minihole data for Line 3 were acquired in nearly ideal wind conditions. Wind speeds recorded at Yucca Mountain and Knothead Gap on November 11 were between 1 and 4 m/s (2.2 to 8.9 mi/hr).

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Table 9. Acquisition Parameters for Line 3

Parameters are the same as for Line 2 with the following exceptions and/or additions:

Parameter	Description
VP Interval	165 ft (~50 m; every 2nd flag)
Receiver spread	441 channel, symmetric split spread, 240 channels on a side of source, ~6 km maximum offset on each side of source, roll into and roll out of full 441 channels on end of line
CDP fold	Nominal 100 at full fold
Minihole Pattern	10 lbs of UNIMAX explosive over 80 ft in 5 miniholes each 10 ft deep centered on flag, 2 lbs explosive per hole.
Minihole Record Length	8 s
CDP fold	125 nominal fold

During the acquisition of Line 3, a number of ongoing activities at Yucca Mountain generated high levels of seismic noise. These noise sources included road grading and quarrying operations, drilling and boring activities, light trucks driving along the seismic line, diesel-driven electrical generators on drilling platforms, operations with the tunnel-boring machine (TBM), and helicopters passing near the seismic line. We were successful in shutting down most of these activities during working days, and found that data acquisition at night or on the weekends also eliminated most of these noise sources. When these sources could not be shut down, however, they noticeably degraded the quality of the seismic data.

Surveying of Lines 2 and 3, by Extreme Surveys, Inc., provided horizontal coordinates accurate to a tenth of a foot and vertical elevations to within a hundredth of a foot. The survey coordinates were plotted on 1:24,000 topographic maps and written in standard SEISURV 3.6 format on magnetic floppy disks in DOS format. Normal industry survey closure procedures were employed, resulting in maximum horizontal closure errors of 13.0 and 5.5 m for Lines 2 and 3, respectively, and in maximum vertical closure errors of 0.61 and 0.40 m for Lines 2 and 3, respectively.

Ancillary Data

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Field processing of the seismic reflection data was performed by Geophysical Control, Inc., using MicroMAX seismic processing software. The field processing was used to help guide the selection of field parameters used for Lines 2 and 3 as well as to monitor data quality during the acquisition of these lines. In addition to plotting the common shot data, and performing spectra of some of the parameter test data, the field processor also produced brute sections for three portions

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of Line 2, including (1) a portion at the beginning of the line, (2) a section near the middle of the line in Crater Flat, and (3) the northeastern end of the line containing all of the Poulter-charge data. In addition, the field processor made a brute section of the deep shot hole data along Line 2. The activities, hardware and software, and products of the field processor were detailed by C. Tonish ["Yucca Mountain Project: Seismic data QA/QC and field processing, Oct/Nov 1994", unpublished report, 1994].

A team of University of Nevada/Reno (UNR) seismologists, headed by Dr. Glenn Biasi, recorded absolute shot hole explosion times required for tomographic analysis of the explosion data recorded by the UNR seismic net. Northern Geophysical of America provided an electrical trigger for the UNR recorders whenever a shot tone was transmitted. This trigger was recorded by UNR for all the shot holes. In addition, as a backup, UNR collocated seismic recorders along our geophone array. The travel time of the first arrival to the UNR instruments determined from field plots can be used to determine the absolute shot time (in universal coordinated time, UCT).

Densely sampled potential-field data along the seismic reflection lines were acquired by the USGS subsequent to the seismic work in late November 1994 and February 1995. Data types include coincident ground magnetic stations with a maximum spacing of 25 m and an average spacing of 10 m along the seismic profiles, offset ground magnetic traverses (same spacing) from Amargosa Desert to drill hole USW VH-1 [Langenheim and Ponce, in review], and aeromagnetic coverage for the remainder of the lines [Sikora and others, in press]. The ground magnetic data show large anomalies caused by surficial volcanics at Little Cones and Red Cone and at powerlines near St. 240 on Line 2. Correlation of magnetic anomalies and the seismic data are presented later in this report and by Langenheim and Ponce [in review].

Collection of gravity data along the seismic reflection profiles was conducted by Ernie Majer, Ken Williams, and staff from the Lawrence Berkeley Laboratory (LBL) and completed in December 1994 [E.L. Majer, written commun., 1995, in Appendix 1 in LBL Letter Report, April 1995, WBS 1.2.3.11.2 Surface-Based Geophysical Testing]. Gravity stations were made at 100-m spacing along the seismic profiles, tied to the seismic station flags. Gravity data were acquired using two LaCoste and Romberg Model G gravity meters. Field terrain corrections were not made. All gravity measurements were tied to the absolute gravity station MERCA, located in the USGS Core Library building in Mercury, Nevada [Zumberge and others, 1988]. Data reduction, including removal of solid-earth tide, meter drift correction, Bouguer correction, and topographic correction, was performed by LBL and the USGS. A regional correction using the principle of isostasy was also applied to the data to model and remove long-wavelength effects due to deep compensation for topographic loads [Simpson and others, 1986]. Three inaccurate gravity readings are noted along Line 2, at km 12.3, km 17.4, and km 25 (fig. 19A). One inaccurate gravity reading is noted along Line 3, at km 2.1 (fig. 21A). The data acquired along Lines 2 and 3 fill an important gap in continuous gravity coverage across Crater Flat and Yucca Mountain.

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Gravity Modeling

Two-dimensional modeling of the isostatic residual gravity data (reduced at a density of 2.67 g/cm^3) was performed using HYPERMAG [Saltus and Blakely, 1993]. Because of the densities used in this reduction, Yucca Mountain is expressed as a local gravity low (with an amplitude of 6 to 10 mGal). Densities used in the model were derived from seismic refraction data [Mooney and Schapper, 1995] and from density measurements [Snyder and Carr, 1984; Langenheim, 1995]. Densities do not necessarily reflect lithologies, but in general reflect the increase in density with depth [Snyder and Carr, 1984]. In the model, densities within the Tertiary volcanic section increased from 2.0 to 2.5 g/cm^3. The density of the Paleozoic section was fixed at 2.72 g/cm^3, consistent with Paleozoic densities measured in samples from UE-25 p#1 and on hand samples from Bare Mountain. Two models for each line are shown (figs. 19 and 21). Both pairs of models fit the gravity data equally well but show a different geometry for the eastern boundary of the Crater Flat basin. One set of models fits the gravity data with a single, gently sloping surface on the top of the Paleozoic (figs. 19A and 21A) whereas the other set of models breaks this surface into two steps corresponding to the Solitario Canyon and Ghost Dance faults (figs. 19B and 21B), consistent with the geometry imaged in the seismic reflection data. Under Yucca Mountain, the depth to pre-Tertiary basement derived from gravity modeling is consistent with the depth from the seismic reflection data. The geometry of the basement surface under Crater Flat is similar to that imaged in the seismic reflection data if the thicknesses of the shallower units (for example, the 2.2 g/cm^3 layer) are increased in the region between USW VH-1 and the Solitario Canyon fault. Gravity data along the eastern part of Line 3 indicate that the basement surface is essentially flat. More detailed correlation of the gravity data and the seismic data is presented later in this report.

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COMPARISON OF FIELD SHOT RECORDS

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As discussed previously, a combination of logistical and environmental requirements led to the hybrid use of vibrator, Poulter surface charge, and minihole sources along Lines 2 and 3. Different sources were overlapped by two source points to allow phase matching of the different sources. These overlaps led to the acquisition of multiple records at the same source point, providing a total of nine comparisons of records obtained using vibrator and Poulter sources and four comparisons of records obtained using vibrator and minihole sources. In addition, there are 14 comparison records obtained using vibrator and deep shot hole sources and two comparisons each of records obtained using Poulter and deep shot hole sources and records obtained using minihole and deep shot hole sources.

We focused our analysis on those records from portions of the lines displaying reflections within the upper 2 s of the seismic sections. This criterion focused our comparison to those parts of the seismic lines which successfully imaged subsurface structure.

Figure 6 compares data recorded by vibrator and Poulter sources on Line 2 at St. 941 (in Solitario Canyon). Poulter charges were the least energetic type of source employed during our survey; during windy conditions they did not provide clear first arrivals out to the maximum offset of 6 km. Under favorable wind conditions, however, Poulter sources provided clear first break arrivals to maximum offsets of 6 km and provided records comparable in quality to those obtained with vibrator sources. In most cases the first breaks of the Poulter data are easier to pick than those of the vibrator sources, permitting better refraction-static models to be developed. Vibrator methods, however, permit better suppression of ambient noise and the air-wave arrival, which can be very large on Poulter-source data. On unprocessed field shot records, the Poulter-source data have a lower frequency than do the correlated field shot records for the vibrator-source data (fig. 6). Spectra indicate that the Poulter sources have significant energy down to about 4 Hz, whereas the vibrator sources with a 10- to 50-Hz sweep have little energy below 11 Hz. The stacked section for Line 2 indicates that the Poulter sources imaged reflections at least 2 s two-way travel time (twtt) below the surface.

Figure 7 compares data recorded using vibrator and minihole sources on Line 3 at St. 416. All the minihole data were acquired in very favorable wind speed conditions. The minihole sources provided clear first breaks out to the maximum offset of 6 km, which were easier to pick than those of the vibrator source. On balance, records obtained using minihole sources compare favorably to those obtained using vibrator sources. The minihole sources produced little if any air wave energy, but did generate larger-amplitude surface waves than did the vibrator sources. On unfiltered field shot records, the minihole data have a lower frequency appearance than do the correlated field shot records for the vibrator data. Spectra indicate that the minihole sources have significant energy down to about 5 Hz.

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DATA PROCESSING

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Data acquired along Lines 2 and 3 were processed interactively by Texseis, Inc. using ProMAX release 5.1 seismic reflection processing software. A standard data processing flow was used, as detailed in Table 10. This flow included vibroseis correlation and compensation filter for vibrator data to match explosion data, refraction and datum statics, F-K filter (after normal moveout (NMO) to flatten reflection events), constant velocity stacks for functions at 250 ft/s intervals, NMO and mute, surface-consistent residual statics, datum correction, CDP stack, post-stack bandpass filtering, scaling, F-X deconvolution, depth conversion, and Stolt post-stack migration. The nominal fold for Line 2 was 60, although beneath the crest of Yucca Mountain the fold exceeded 90. The nominal fold of Line 3 was 125. Fold ramped up and off the ends of both lines for 3 km. Much of the reflection signal was carried by the low-frequency part of the spectrum; surface-consistent deconvolution tended to eliminate the low-frequency signal and was therefore not applied.

Careful velocity and statics analyses were required by the large topographic relief of Yucca Mountain and spatially varied surficial velocities. Datum statics were applied using a floating datum and a datum velocity of 5000 ft/s. The 5000 ft/s value chosen was selected due to the presence of stacking velocities less than 6000 ft/s along portions of Lines 2 and 3.

Refraction statics were determined from first breaks (refractions) to offsets of 4000 ft. Refraction first breaks were used to derive a two-layer model; the near-surface weathering zone varied from about 300 to 400 ft (90 to 120 m) thick, having velocities between 2000 and 9000 ft/s (600 to 2750 m/s). The underlying layer had velocities between 5500 and 12,000 ft/s (1680 and 3660 m/s). Weathering-layer corrections made using refraction statics were compared to those generated solely using elevations. Refraction-based weathering statics produced slightly superior stacks than did the elevation-based weathering statics, so we applied refraction statics. Plots of both types of weathering statics determined for both lines are typically within 50 msec. Larger misfits of about 100 msec were noted only at the crest of Yucca Mountain.

Iterative passes of velocity analysis and statics analysis were required to optimize the final sections. The sections shown here consist of two passes of velocity analysis and surface-consistent residual statics. Well log data and stacking velocities from Line AV-1 were used to guide velocity selection. Color screen dumps of the stacking velocities, superimposed on the final sections (fig. 8) show that the stacking velocity function varied smoothly over both Lines 2 and 3; more complex velocity functions did not help stack in reflections. The smooth stacking velocity functions indicate that the reflection events imaged in Figures 10 to 17 result from reasonable stacking velocities.

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Table 10. Data Processing Scheme for Lines 2 and 3

Processing Step	Description
SEG-D to SEGY Conversion	Demultiplex all four sources
Separate Sources	Vibroseis Data Cross-correlate zero phase Design compensation filter from sweep Apply compensation filter Deep-hole dynamite data Tape output 0-8 s Tape output 0-20 s Apply uphole correction Poulter Data Minihole dynamite data
Merge all sources	Use 0-8 s deep-hole dynamite for statics
Build and apply geometry	In place header definition
Trace edit	
Refraction Statics	Pick first breaks using absolute offsets of 1000-5000 ft and all sources
Datum Statics	Processing Datum is Floating 5000 ft/s replacement velocity
F-K Filter	Apply NMO (brute functions) correction Apply and save AGC FK rejection filter +/- 5000 ft/s Remove AGC Remove NMO correction
Constant velocity stacks	250 ft/s increments from 4000 to 23000 ft/s
NMO Correction and Mute	50% Stretch Mute
Residual Statics	Surface Consistent Residual Statics Window 0.5 to 2.3 s Prefilter 5/10 to 35/50 Hz
Constant velocity stacks	For Stack Velocity Functions
NMO Correction and Mute	50% Stretch Mute
Residual Statics	Surface Consistent Residual Statics Window 0.5 to 2.3 s Prefilter 5/10 to 35/50 Hz
Scaling	500 ms sliding gate

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Table 10. Continued

Processing Step	Description
Datum Correction	Final Datum is 5000 ft Use replacement velocity of 5000 ft/s
CDP Stack	
Bandpass Time Variant Filter	5/10-40/60 Hz
Scaling	500 ms sliding gate
FX Deconvolution	
Stack Display	Color and black and white
Depth Conversion	Using 80% of Stacking Velocities
Post-stack migration	Stolt Algorithm using 70% of Stacking Velocities

Depth conversions of the final sections were calculated using a velocity function representing a fixed percentage of the stacking velocities. A range of percentages of the stacking velocity function were tested for depth conversion. The value selected for all of Line 3 and most of Line 2, 80%, provided the best fit of the depth of the inferred Paleozoic/Tertiary reflection to the depth to the top of Paleozoic rocks in UE-25 p#1. Within the Tertiary fill along the southwestern end of Crater Flat, however, it was necessary to lower the depth-conversion velocity to 60% of the stacking velocity. This choice provided a better match to the depth of the Tertiary fill estimated from the depth-converted section with previous estimates based on gravity and seismic refraction data [Langenheim, 1994; Mooney and Schapper, 1995] and is reasonable given the steep dip of reflections from beneath this zone, which require higher stacking velocities than expected for the fill. Using a higher percentage of the stacking velocities in this location, say 80%, leads to thicknesses of Tertiary fill of over 5000 m. This greater thickness is not compatible with either the density modeling or the seismic refraction data. These depth conversions were also compared to those obtained using interval velocities derived from the east-west trending refraction model near Lines 2 and 3 [Mooney and Schapper, 1995]. The refraction velocity model yielded very similar depths to the Paleozoic/Tertiary contact in the Amargosa Desert and the center of Crater Flat but overestimated the depths to the top of the Paleozoic section along Line 3 as judged from UE-25 p#1 and beneath Yucca Mountain on Line 2. The overestimation of depths to Paleozoic rocks in this vicinity using the refraction velocities is probably related to the failure of the refraction method to account properly for the interbedded high- and low-velocity layers within the Miocene tuff

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sequence (fig. 9), yielding average velocities that are too high. We conclude that the depth conversions achieved using percentages of the stacking velocity are preferable, and based on this comparison with the refraction velocity model and drilling results from UE-25 p#1, provide reasonable depth estimates along both Lines 2 and 3.

Post-stack migration was performed using the Stolt algorithm. Migration velocities of 50%, 60%, 70%, 75%, 80%, 85%, 90%, 95%, and 100% of the stacking velocity were compared; the migration velocity of 70% of the stacking velocity yielded the best results. A choice of higher stacking velocities led to over-migration of the deeper, more steeply dipping reflections and to some defocusing of the seismic image. The migrated sections, although generally low in quality, do provide some important guidance, particularly for the interpretation of the deeper, steeper-dipping structure.

Processing of the low-fold deep shot hole data followed a somewhat different sequence. With the intent of choosing the best shot gathers to make a low- or single-fold section for the lower crustal section (5 to 10 s), data were plotted with and without preprocessing, including bandpass and F-K filtering. These plots revealed no deep-crustal reflections northeast of St. 600, near USW VH-1. Up to 8-fold stacks of the data also revealed no lower crustal reflections beyond this point. Upon this discovery, we made no further attempt to process these data.

VSPs and WELL LOGS

Vertical seismic profiles (VSPs) for seven wells along Lines 2 and 3 were acquired by Birdwell Well Services, Incorporated under contract between 1981 and 1983, using geophone spacings of 25 ft and 50 ft (7.6 and 15 m) and vibrator sources (15 to 80 Hz) [Fenix and Scisson, Inc., 1986a, 1986b, 1986c, 1987]. VSPs provide a measure of the two-way travel times to known stratigraphic horizons (Table 11). Comparison between these times and those measured from the synthetic seismograms described below indicate that the observed two-way travel times (twtt) are always slightly greater than would be inferred from the synthetic seismograms (Table 12). For example, at UE-25 p#1, the VSP places the top of the Tram Tuff of the Crater Flat Group at 0.52 s twtt, the top of the Paleozoic section at 0.81 s twtt, and the bottom of the hole (at 1798 m) at 0.98 s twtt. These times are approximately 0.04 s greater than those inferred from the synthetic seismograms (Table 12). At USW VH-1, the VSP places the bottom of the hole (at 747 m) at 0.564 s twtt, about 0.1 s twtt deeper than inferred from the synthetic seismograms. Generally, the

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Table 11. VSP Data#

USW VH-1

Depth (ft)	TWTT (sec)	Unit*
0	0.000	QTac
95	0.068	Top Tb
175	0.088	Top QTac
510	0.184	Top Tpc
600	0.214	SWL
870	0.256	Top Tpt
1860	0.452	Top Tcp
2030	0.494	Top Tcb
2450	0.564	Base of VSP

USW WT-7

Depth (ft)	TWTT (sec)	Unit*
0	0.000	Tpc
395	0.124	Top Tpt
1390	0.354	SWL
1430	0.358	Top Tht
1575	0.396	Top Tcp/Base of VSP

USW WT-2

Depth (ft)	TWTT (sec)	Unit*
0	0.000	Tpc
275	0.111	Top Tpt
1300	0.314	Top Tht
1590	0.386	Top Tcp
1875	0.448	SWL
2025	0.474	Base of VSP

USW H-4

Depth (ft)	TWTT (sec)	Unit*
0	0.000	Tpc
215		Top Tpt
1315	0.343	Top Tht
1625	0.414	Top Tcp
1700	0.430	SWL
2275	0.530	Top Tcb
2660	0.594	Top Tct
3815	0.774	Top Tlr
3975	0.802	Base of VSP

USW H-6

Depth (ft)	TWTT (sec)	Unit*
0	0.000	Qac
25		Top Tpc
300		Top Tpt
375	0.384	Top Tht
505	0.412	Top Tcp
725	0.462	SWL
800	0.480	Top Tcb
855	0.554	Top Tct
880	0.666	Top Tll
710	0.780	Top Tlr
950	0.830	Base of VSP

UE-25 p#1

Depth (ft)	TWTT (sec)	Unit*
0	0.000	Qac
130	0.100	Top Tmr
175		Top Tpc
270	0.144	Top Tpt
1190	0.334	SWL
1250	0.342	Top Tht
1420	0.374	Top Tcp
1820	0.446	Top Tcb
2260	0.514	Top Tct
2870	0.600	Top Tlr
3500	0.711	Top Tta
3610	0.732	Top Ttc
3730	0.754	Top Tc
3840	0.774	Top Tca
3950	0.788	Top Tcf
4080	0.806	Top Slm
5900	0.980	Base of VSP

#From Fenix and Scisson, Inc. (1986a, 1986b, 1986c, 1987).

*From Nelson and others (1991).

Abbreviations: Qac, alluvium; QTac, alluvium and colluvium; Tmr, Rainier Mesa Tuff of the Timber Mountain Group; Tpc, Tiva Canyon Tuff of the Paintbrush Group; Tpy, Yucca Mountain Tuff of the Paintbrush Group; Tpt, Topopah Spring Tuff of the Paintbrush Group; Tht, Rhyolite of Calico Hills Formation; Tcp, Prow Pass Tuff of the Crater Flat Group; Tcb, Bullfrog Tuff of the Crater Flat Group; Tct, Tram Tuff of the Crater Flat Group; Tll, lavas and flow breccias of Crater Flat Group; Tlr, Lithic Ridge Tuff; Slm, Lone Mountain Dolomite; SWL, Static water level.

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Table 12. VSP Data versus Synthetic Seismograms

Well Name	Depth to Base of Log (ft)	Calculated Two-way Travel Time To Base of Log (sec)	Base of VSP (ft)	Two-way Traveltime to Base of VSP (sec)	Basal Unit
UE-25 p#1	5910	0.94	5900	0.98	Slm
USW H-6	3980	0.83	3950	0.83	Tlr
USW VH-1	2477	0.46	2450	0.56	Tcb
USW H-4	4004	0.79	3975	0.80	Tlr
USW UZ-6	1856	0.46	1840	0.50	
UE-25 UZ-16	1676	0.37			
USW WT-7	1589	0.33	1575	0.40	Tcp

VSP data show that the synthetics underestimate total two-way travel times by amounts varying only between 0.03 and 0.1 s, providing general support for the times inferred from the synthetics.

Reasonably complete digital borehole compensated-density logs (DBC) are available for seven wells along Lines 2 and 3 (Table 13). These density logs contain gaps at the top of wells yet on average cover more than 90% of each well. Incomplete digital velocity logs (PVEL) are also available for four of these wells, including USW VH-1, USW H-6, USW H-4, and UE-25 p#1. As noted by Nelson and others (1991), velocity logs can only be acquired in liquid-filled boreholes, and the water table is unusually deep in the vicinity of Yucca Mountain, leading to large intervals at the top of the wells which could not be logged with this tool. Both logs were used to generate synthetic, vertical-incidence seismograms using modules LOGINIT and LOGPROC of DISCO Version 9.0 software.

As previously noted, all the velocity logs lack substantial amounts of data at the top of the well and contain gaps within the logs, and in total lack data for between 25 and 68% of each well (Table 13). Calculation of synthetic seismograms, however, requires complete logs for both density and velocity, as null values in either would generate spurious seismic reflections. It was necessary, therefore, to fill in gaps in the velocity logs using the more complete density logs. Comparison of observed density and velocity values for the four wells that have both logs revealed that Lindseth's formula (velocity (ft/sec) = 3460/(1.0-0.308 x Den)) yielded a more accurate prediction of velocity from density than Gardner's formula (velocity (ft/sec) = $(\text{Den}/0.23)^4$), where Den=Density(g/cm^3). We therefore filled in gaps in the velocity logs using Lindseth's formula.

Further, as noted by Nelson and others [1991], the density logs from the vicinity of Yucca Mountain suffer from two major problems. First, the density-tool compensation algorithm does not work well in air-filled boreholes above water table, yielding noisy logs and consequently noisy

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calculated-velocity logs. Second, at depth intervals in which the hole is rugose, the density tool may become separated from the rock wall and provide spuriously low density values. For the wells analyzed here, these intervals typically correspond to zones where the caliper values become unusually large, indicating a wide borehole. This second problem was related to constraints on using drilling fluids above the water table. Thus, both problems are restricted to the interval of the holes above water table; below water table there are relatively few problems with the density logs.

Due to these problems, all the well logs required substantial editing prior to the calculation of synthetic seismograms. The density logs were first desampled to a one-ft sample interval from the original 0.5-ft sample interval, extrapolated to the surface, and then used to interpolate missing portions of the velocity logs from Lindseth's formula. For wells USW UZ-6, UE-25 UZ-16, and USW WT-7, Lindseth's formula was used to generate the entire velocity log from the existing density log. Where velocity and density logs both contained gaps, both of these values were interpolated linearly across the gaps in the logs. Where a gravity log existed, as for UE-25 p#1, it was used to predict density values missing from the DBC log. (Gravity logs were obtained in some holes using a downhole gravity meter [Nelson and others, 1991].) Densities less than 1.0 g/cm^3 were increased to a minimum of 1.3 g/cm^3, and corresponding velocities less than 5000 ft/sec were increased to a minimum of 6000 ft/s. Similarly, above the water table, and except for the Tertiary basalt section of USW VH-1, densities above 2.5 g/cm^3 were reset to 2.5 g/cm^3, and their corresponding velocities were reset to 12,000 ft/sec. In some cases, the velocities in gaps calculated from Lindseth's formula were increased by hand in order to better match velocity values on either side of the gaps.

The final, edited well logs were converted to integer ASCII values and copied to the DISCO system. The final logs contain depth in integer ft, velocity in ft/sec, and density in kg/m^3. The module LOGINIT was used to read the logs into the YUCCA project name area from disk. The module LOGPROC was used to calculate a sonic well log (SON), impedance log (MLT, KEP), a reflection-coefficient series (TDC), and a primary reflection series (RFC, PRI) from the input velocity and density logs. A 30-Hz Ricker wavelet (defined in FIL and chosen for the mid-range of the 10- to 50-Hz Vibrator sweep) was used to filter the primary reflection series shown here. Display (DIS) was made using wiggle plots for the logs, spike plots for reflection coefficients, and trace plots of the synthetics.

Synthetic seismograms for the shallow holes, USW VH-1, USW WT-7, USW UZ-6, and UE-25 UZ-16, provide information above 0.46 s twtt (fig. 9, Table 13). Synthetic seismograms for UE-25 p#1, USW H-6, and USW H-4 yield information above 0.94 s twtt (fig. 9, Table 13). Given the uncertainty in the density and velocity at the top of the logs, it probably is unwise to attribute much significance to the strong reflections produced by the assumed velocities and densities at the top of the logs. Similarly, it is probably unwise to over-interpret the synthetics in the zones where velocities are interpolated solely from the density. Density logs for USW WT-7

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and USW UZ-6 are similar (figs. 9B and 9C), however, and predict a reflection from near the base of the log at the contact between the Calico Hills Formation and the Prow Pass Tuff of the Crater Flat Group.

Table 13. Digital Well Log Data for Synthetic Seismograms

Well Name	Density Log Coverage (ft)	Velocity Log Coverage (ft)	Percent of Density Log Missing	Percent of Velocity Log Missing	Two-way Travel Time To Base of Logs (sec)
UE-25 p#1	37-5910	1267-5900	4	25	0.94
USW H-6	312-3980	1907-3975	8	48	0.83
USW VH-1	50-2449	801-2477	9	60	0.46
USW H-4	59-4003	2583-4004	20	68	0.79
USW UZ-6	325-1856	None	17	00	0.46
UE-25 UZ-16	40-1676	None	3	00	0.37
USW WT-7	53-1589	None	3	00	0.33

The synthetic seismograms show reflections that are produced at intervals where both density and velocity logs exist. The synthetic for UE-25 p#1 reveals a reflection from 0.76 s from just above the pre-Tertiary/Tertiary boundary (fig. 9G). Reflections from 1400 to 2000 ft (430 to 600 m) are from the Prow Pass and Bullfrog Tuffs of the Crater Flat Group. A large-amplitude reflection calculated at 0.04 s twtt for USW VH-1 is caused by a high-density, high-velocity Tertiary basalt layer noted in the drilling log (Nelson and others, 1991; fig. 9A). Reflections within the Topopah Spring Tuff of the Paintbrush Group are calculated at 1400 ft (430 m) in USW VH-1. A low-velocity layer in the Prow Pass Tuff of the Crater Flat Group in USW H-6 at about 2000 ft (600 m) produces a reflection at about 0.52 s (fig. 9F). The existence of these low velocities in USW H-6 is uncertain, however, given that they occur over an interval in which there is a large excursion in the caliper log [Nelson and others, 1991].

GEOLOGIC INTERPRETATION OF SEISMIC SECTIONS

In this section we describe and present a preliminary geologic interpretation of seismic reflection Lines 2 and 3. Three versions of the seismic sections are presented because it is useful to examine different presentations of the data to guide the interpretation. For instance, stacked sections provide the sharpest and least processed images of reflections, but the reflections do not represent a geologic cross section since they are presented in terms of two-way travel time rather than depth. The depth-converted sections provide a depth estimate of the reflections, without vertical exagerration, but also do not represent a true geologic cross section because dipping

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reflections are not correctly located in the subsurface. Depth conversion tends to make deeper reflections, in high-velocity rocks, appear lower-frequency and provides an estimate of the decreasing vertical resolution with depth inherent to seismic reflection data. Only migrated, depth-converted sections represent a true geologic cross section and are the only sections shown interpreted in this report. Migrations of lower-quality data such as Line 2 and 3 often result in considerable defocusing of the image (producing a wormy appearance), and the collapsing of diffracted energy inherent to migration makes some reflections less obvious. Thus, some reflections are actually easier to identify in the stacked, unmigrated sections, although they are not correctly located in the subsurface. Uninterpreted presentations of all sections are provided. Uninterpreted, unmigrated, and non-depth-converted seismic sections for Lines 2 and 3 are shown in Figures 10 and 11. Both seismic sections are displayed with a final datum of 1500 m (5000 ft) above sea level, although a floating datum was used for the velocity analysis. Plots on these sections also show the elevation along the line, the floating datum used for processing, the stacking velocities (in milliseconds and ft/s) at 1-km intervals, and the fold of the stacked section. The time sections are provided to allow comparisons to other existing and future reflection surveys without introducing the uncertainties involved with depth conversions. Times given in this discussion are generally cited as two-way travel time (twtt) relative to 0.0 s on Figures 10 and 11.

Uninterpreted depth conversions of these seismic sections, plotted without vertical exaggeration, are shown in Figures 12 and 13. Most of the depths given below are cited as depth below the final datum at 1500 m (5000 ft) above sea level. Thus, on all of these plots, the start of data indicates the ground surface. Note that depth-converted sections do not properly account for the location of deeper, dipping events, but do provide reasonable approximations to reflector depths for the shallow, flat-lying reflectors.

Post-stack migrations and depth conversions of the sections are provided in Figures 14 and 15 and are interpreted in Figures 16 and 17. The interpretations in Figures 16 and 17 are based primarily on the depth conversions of these sections, but the depth-converted migrations provide more accurate locations of the deeper, dipping reflections. Table 14 provides a list of geographic locations intersected by both lines for geographic reference. Most of these locations are also presented as top labels along the seismic sections shown in Figures 10 to 17. The hybrid sources used to acquire Lines 2 and 3 are listed in Table 15. Note the overlap in station numbers indicating the overlap of sources used to facilitate processing of these data.

Line 2

Line 2 images seismic reflections at depths between 0.04 km and 24 km (corresponding to travel times between 0.05 s and 8 s twtt). Line 2 crosses four major structural domains, including the Amargosa Desert, Steve's Pass, Crater Flat, and Yucca Mountain (fig. 1B). We discuss the

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observed reflections within these domains in order from southwest to northeast. In general, we first describe the shallowest reflections and work downwards through the section.

Amargosa Desert (St. 101 to 285)

Within the Amargosa Desert a prominent, low-frequency, west-dipping reflection extending about 1 km below the surface is identified as the Paleozoic/Tertiary contact (fig. 16). The primary basis for this identification is the observation that the reflection projects updip to Steve's Pass, near St. 285, close to outcrops of Late Proterozoic and Cambrian clastic units [Swadley and Carr, 1987; Monsen and others, 1992] located about 200 m south and east of the seismic line between St. 280 and 300. The identification of this reflection as the top of the Paleozoic strata also matches density modeling along the line (fig. 19), which defines a southwestwardly thickening Tertiary basin. Up to 400-m down-to-the-west offset of the Paleozoic/Tertiary contact at St. 230 is inferred in Figure 16. This offset is located about 600 m north of an isolated, low, north-trending ridge of Miocene tuffs [Swadley and Carr, 1987], and is inferred to result from a north-trending, down-to-the-west normal fault. Magnetic data along Line 2 (fig. 20) are also

Table 14. Line 2 and 3 Markers

Line 2 Station	Marker*	Line 3 Station	Marker*
235	Highway 95	101	USW H-6
332	Steve's Pass	140	Solitario Canyon Fault
430	Little Cones	167	USW UZ-6
550	Red Cone	206	USW WT-2
646	USW VH-1	210	Ghost Dance Fault
730	Crater Flat Fault	296	Bow Ridge Fault
810	Windy Wash Fault	326	Midway Valley Fault
865	Fatigue Wash Fault	337	UE-25 p#1
938	USW WT-7	360	Paintbrush Canyon Fault
980	Solitario Canyon Fault	370	Fran Ridge
1054	USW WT-2	452	Fortymile Wash
1056	Ghost Dance Fault		
1079	USW H-4		
1088	UE-25 UZ-16		

*Fault locations taken from Simonds and others [in press].

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Table 15. Line 2 and 3 Sources

Line 2 Station	Source Type	Line 3 Station	Source Type
101-945	Vibrator	101-129	Vibrator
945-1133	Poulter Charge	127-165	Poulter Charge
		164-235	Vibrator
		233-315	Poulter Charge
		313-337	Vibrator
		331-439	Minihole Pattern
		437-541	Vibrator

consistent with fault offset of the Miocene tuffs near St. 220 and with north-trending normal faulting near St. 150 [Langenheim and Ponce, in review].

The seismic sections image only poorly the geometry of the Tertiary fill above the Paleozoic/Tertiary contact along this portion of Line 2, perhaps due to the lower fold of the seismic data there. There is, however, a suggestion of a gentle easterly dip of strata into the inferred Paleozoic/Tertiary contact at St. 250 (fig. 16).

Beneath the Amargosa Desert, reflections from the lower crust were successfully acquired using both vibrator and shot hole sources. The depth to the top of the reflective lower crust just above 15 km (4.8 s twtt; fig. 18) is similar to that imaged by line AV-1 to the southeast [Brocher and others, 1993]. The base of the crust, or Moho, is imaged between 9 and 10 s, corresponding to depths between 27 and 30 km (not shown here). This Moho depth was also reported to the southeast in the Amargosa Desert by Brocher and others [1993].

Steve's Pass (St. 285 to 330)

Little coherent seismic energy is present in the vicinity of Steve's Pass (fig. 16). This observation is consistent with the nearly complete absence of Tertiary rocks over this structural high [Swadley and Carr, 1987; Monsen and others, 1992] and our expectation that few coherent reflections within the highly-deformed Proterozoic and Paleozoic rocks might be obtained. A subhorizontal, low-frequency event at 8000 ft below datum is observed beneath the inferred top of Paleozoic rocks between St. 350 and 370. A prominent gravity high over Steve's Pass is the largest positive anomaly in the gravity data along Line 2 (fig. 19). Density models are consistent with the outcrop of Proterozoic and Paleozoic rocks in this location (fig. 19), although the model slightly underpredicts the gravity field southwest of the pass and overpredicts the field northeast of the pass.

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Crater Flat (St. 330 to 910)

Several sets of reflections were observed from Crater Flat, and the data from Crater Flat probably represent the best data acquired during our survey. The data from Crater Flat are notable for the depth to which coherent reflections can be observed as well as the lateral continuity of reflections.

Prominent, subhorizontal reflections about 150 m deep (0.15 s twtt below the surface) may be traced continuously for over 5 km between Little Cones and USW VH-1 (St. 430 and 646; figs. 1B and 16). We interpret these reflections as thin basaltic flows based on the VSP at USW VH-1 (Table 11) and their high-amplitude, low-frequency character. This character is similar to that of reflections inferred to represent shallow basaltic flows along Line AV-1 [Brocher and others, 1993]. The reflections dip gently westward near USW VH-1 but appear nearly unfaulted between Little Cones and Red Cone. Vertical offsets on the inferred basaltic flows are minor, less than 13 m, consistent with the relatively flat character of the ground magnetic field (where not disrupted by magnetic fluctuations caused by the basaltic debris from Little Cones and Red Cone; fig. 20). The apparent continuity of these events is not considered to be an artifact of data processing because surface-consistent residual statics were determined using three different windows between 0.5 and 2.3 s twtt (fig. 10) and were not selected to minimize the apparent structure on this reflection. Basaltic flows intersected at 366 m depth in USW VH-2, located about 2.4 km NNW of St. 602, dated as 11.3 Ma [Carr and Parrish, 1985], may be correlative with the deeper reflector on Line 2. The shallow basaltic flow intersected by USW VH-1, dated as 3.7 Ma [Carr, 1982], may be correlative to the shallower reflector on Line 2. Thus, both reflectors are inferred to be older than Little Cones or Red Cone, which are dated as 1.1 and 1.0 to 1.5 Ma, respectively [Vaniman and others, 1982].

The inferred shallow basaltic reflectors are underlain by coherent reflections which clearly define a thin, asymmetric, west-dipping basin up to 1.2 km (3600 ft) deep between Steve's Pass and USW VH-1 (St. 380 and 650; fig. 16). The base of the basin is defined by reflections from an unconformity at the bottom of the basin. These intersect USW VH-1 (Station 645) at 0.18 s subsurface; this time correlates to VSP and synthetic travel times with the top of the Tiva Canyon Tuff of the Paintbrush Group (Table 11). The unconformity may be traced as far to the northeast as the Fatigue Wash fault where it truncates west-dipping reflections (St. 875) and appears to deepen slightly northeast of USW VH-1 (fig. 16). The shallow reflections above the unconformity do not show significant vertical offset. This basin strongly resembles the shallow basin proposed for this location by Carr and Parrish [1985] based on drilling results from USW VH-2. The existence of this basin was disputed by Hamilton [written commun., 1991], who suggested that the data were also consistent with a tilted block, but its existence may be consistent with low-amplitude folding in Crater Flat produced by N-NE to S-SW directed shortening [Fridrich, written commun., 1995].

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Northeast of Steve's Pass, a series of high-amplitude, moderately east-dipping events extend from the surface to 2100 m (7000 ft) below datum (2 s twtt below the surface). These east-dipping reflections project to the surface just northeast of Steve's Pass (between St. 330 and 360), where Monsen and others [1992] inferred three faults beneath surficial cover. For this reason we interpret them as several faults, with the strongest event projecting to St. 330 representing the Bare Mountain fault. On the migrated, depth-converted section (fig. 16) we have interpreted the Bare Mountain fault as truncating a series of prominent, low-frequency subhorizontal reflections on their eastern side. The origin of these subhorizontal reflections is unknown, but based on density models (fig. 19) we interpret them as originating within the Precambrian and Paleozoic section beneath Bare Mountain. Regional gravity data suggest that Line 2 crosses the Bare Mountain fault at a high angle, making it nearly a true dip line in this location [Langenheim, 1995]. If so, the depth-converted migration (fig. 16) suggests that the Bare Mountain fault has a dip of about 42° consistent with the density models (fig. 19). The large amplitudes of the reflections are compatible with their origin at the Paleozoic/Tertiary contact.

In the southwestern half of Crater Flat west-dipping reflections extend as much as 3800 m (12,500 ft) below the surface (fig. 16). These west-dipping reflections appear to be truncated by and rotated into the reflection inferred to represent the Bare Mountain fault and are interpreted as reflections from the Tertiary fill beneath Crater Flat. The nearly 4000-m thickness of Tertiary units is in close agreement with the 3300 to 3500 m inferred from seismic refraction and gravity data [Langenheim, 1995; Mooney and Schapper, 1995]. Beneath Red Cone we interpret the migrated data as indicating that the basin floor dips westward (fig. 16), contrary to the density models (fig. 19). To the east, west-dipping reflections inferred to represent Tertiary basin fill are underlain by prominent, west-dipping reflections between Red Cone and the Crater Flat fault (St. 550 and 700) at a depth between 15,000 and 8,000 ft (4600 and 2500 m) below datum (twtt between 1.6 and 2.4 sec). These prominent reflections are inferred to represent the Paleozoic/Tertiary boundary due to their large-amplitude, low-frequency character and relative continuity. This interpretation is qualitatively consistent with the density models, which show the Paleozoic/Tertiary contact ramping up eastward at a gentle angle between USW VH-1 and the Windy Wash fault (St. 640 to 820; at km 18 on fig. 19). The density model, however, fails to properly account for the low-amplitude gravity anomalies in this vicinity. The interpretation of the Paleozoic/Tertiary contact shown in Figure 19 in this location is simple, and we acknowledge that additional small offset structures on this contact could be interpreted in this region (near St. 750).

We interpret a short, subhorizontal reflection between St. 600 and 625 and at a depth of 5300 m (17,500 ft) below datum (3.2 s twtt) lying below this inferred Crater Flat half-graben as occurring within the Precambrian and Paleozoic section. As such, it could represent a stratigraphic boundary in the Precambrian/Paleozoic section or a part of a detachment surface. We acknowledge that this reflection is probably too shallow to represent a postulated detachment

beneath Crater Flat [Scott, 1990]. An alternate model is suggested by seismic refraction data from the base of Crater Flat in this location which show high (6.8 km/s) velocities, as much as 1 km/s higher than adjacent "basement" rocks [Mooney and Schapper, 1995]. Although the 6.8 km/s velocities could represent Paleozoic carbonate rocks (see well log data from UE-25 p#1; fig. 9G), a more interesting speculation is that these velocities could also represent refractions from a thick mafic intrusion into the Precambrian and Paleozoic section. Because mafic sills are known to produce high-amplitude reflections elsewhere in the Basin and Range [Goodwin and others, 1989], and a mafic sill could also provide the deep magnetic source needed to explain the broad magnetic anomaly within Crater Flat (fig. 20), an anomaly which can not be explained by shallower magnetic structures within the Tertiary fill [Langenheim, 1995; Langenheim and Ponce, in review], a mafic intrusion could explain these subhorizontal reflections. Qualitatively, these reflections appear to be in a location and depth expected for the deep magnetic source. A mafic sill is not required, however, because Langenheim and Ponce [in review] suggest that the Devonian Eleana Formation might also be the source of the broad magnetic anomaly.

Deeper reflections are not sharply imaged between the Crater Flat and Fatigue Wash faults (St. 750 and 875). We identify, however, a discontinuous, undulatory, low-frequency reflection at about 3000 m (10,000 ft; 1.8 to 1.9 s twtt) below datum (fig. 16); this event is even clearer in the intermediate section (fig. 18). Based on its character and depth, we infer that it is the Paleozoic/Tertiary boundary. The disrupted character of the reflection (which is more clearly observed in the intermediate level processing of this line (fig. 18) than in Figure 16) probably results from closely-spaced normal faults mapped at the surface (for example, Crater Flat, Windy Wash, and Fatigue Wash faults; fig. 16) and is consistent with magnetic anomaly data (fig. 20) showing fault spacings on the order of 1 to 2 km [Langenheim and Ponce, in review]. The relatively subdued dip of this horizon is consistent with isostatic gravity anomaly data, which are nearly flat in this region, suggesting that the Paleozoic/Tertiary boundary rises only modestly to the east in this location (fig. 19). We infer that prominent, west-dipping reflections at station 781, about 1500 m (5000 ft) below datum, are produced within the Tertiary section. This reflection may be projected discontinuously westward beneath depths reached by USW VH-1, making this horizon older than the Bullfrog Tuff of the Crater Flat Group.

Lower-crustal reflections can be observed beneath Crater Flat as far northeastward as Red Cone where it resembles those seen in the Amargosa Desert (St. 600; fig. 18; Brocher and others, 1993). Vertical striping of these reflections is attributed to variable near-surface conditions providing windows into the lower crust and are not interpreted as being indicative of the structure of the lower crust. We postulate that northeast of Red Cone (St. 600) the water table was too deep to couple strongly either the vibrator or shot hole seismic energy into the ground.

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Yucca Mountain (St. 910 to 1133)

Reflections from the vicinity of Yucca Mountain are difficult to interpret for several reasons. The most important of these include (1) difficulties created by the strong topographic relief across the mountain, requiring a change of seismic sources and causing large statics and rapid lateral changes in seismic velocities, and (2) problems caused by the highly oblique geometry of the line relative to structural dips. Despite these major difficulties, we believe that very useful and mappable seismic reflections were obtained beneath Yucca Mountain (fig. 16).

An important stratigraphic and structural event is imaged nearly continuously across Yucca Mountain about 500 m (1600 ft) below the surface (time about 0.4 s twtt below the surface). This long, multicyclic event can be correlated to VSPs at wells USW WT-7, USW WT-2, and USW H-4 (Table 11) and originates at or near the top of the Prow Pass Tuff of the Crater Flat Group. The multicyclic character of the reflection indicates that it originates from constructive interference from several units within the Prow Pass and Bullfrog Tuffs. The three cycles which characterize this event thicken slightly to the west, which we interpret as westward stratigraphic thickening across Yucca Mountain of the Prow Pass and possibly Bullfrog Tuffs also inferred from geologic evidence [Fridrich and others, 1994a]. This observation is geographically restricted to Line 2 between USW WT-7 and UE-25 UZ-16 and is contradicted by the thickness contours of the Prow Pass Tuff by Moyer and Geslin [1995] but not by their data points. Structurally, the event broadly parallels or subparallels topography except between USW WT-7 and the Solitario Canyon fault, where it dips significantly to the west. Scott's [1990] suggestion of wide areas of western dips between pairs of block bounding faults is supported by the observation of local westward stratal dips in Solitario Canyon [D.C. Buesch, oral commun., 1995] but further supported by the reflection line only in the vicinity of the Solitario Canyon fault. We note, however, that detailed mapping elsewhere at Yucca Mountain does not yield westward dips of Miocene strata [Dickerson and Spengler, 1994], nor do we observe western dips in the seismic data elsewhere at Yucca Mountain.

Within the resolution of the seismic reflection data, which is limited by the low frequency of the event to several meters, little if any disruption of the Prow Pass Tuff event is inferred in the vicinity of the Ghost Dance fault, which has important implications for the recent history of this fault [see Spengler and others, 1993, 1994; Simonds and others, in press]. The Ghost Dance fault, however, does appear to mark a monocline in the Prow Pass Tuff. This monocline may have formed over the simpler offset of the Paleozoic/Tertiary contact beneath it as suggested by Fridrich [written commun., 1995] for Yucca Mountain structures generally but not specifically for the Ghost Dance fault. In fact, given the very small offset of this fault at the surface (very much less than 30 m) any disruption of the Prow Pass Tuff reflection would be surprising. Broadly speaking, there is little if any resolvable vertical offset of the Crater Flat Group across Yucca Mountain, apart for that in the vicinity of the Solitario Canyon fault.

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discontinuous, undulose, low-frequency reflection observed over 5 km between St. 700 and 910 at 1.8 s twtt (3000 m below datum). This persistent event may be traced discontinuously over 3.6 km beneath Yucca Mountain (from St. 910 to St. 1090) at nearly the same depth (1.9 s twtt from datum) as to the west. Vertical down-to-the-west offset of this horizon in the vicinity of the Solitario Canyon fault may be as much as 230 m (0.1 s twtt). An apparently more significant component of down-to-the-west displacement occurs just to the west of the mapped location of the Ghost Dance fault, where up to 450 m (0.2 s) of offset is inferred (fig. 16). The event ties to Line 3, where UE-25 p#1 indicates the reflection is at or just below the Paleozoic/Tertiary contact. This interpretation is strengthened by density models indicating that the Paleozoic/Tertiary boundary is located about 2500 to 3000 m beneath the crest of Yucca Mountain (fig. 19). The nearly 1000 m of aggregate offset of the inferred Paleozoic/Tertiary contact on all the faults in the vicinity of the crest of Yucca Mountain is also consistent with gravity data [Langenheim, 1995]. More than 500 m of structural relief on the Paleozoic/Tertiary contact in this region has been proposed based on the thickening of Miocene tuffs inferred from well and gravity data [Fridrich and others, 1994a]. A graben is proposed to have formed along this portion of Line 2 from 14 to 13.5 Ma based on these well data [Fridrich and others, 1994a; Fridrich, written commun., 1995]. Perhaps due to declining fold of reflection coverage, this event cannot be traced farther to the east than St. 1100 on Line 2 (fig. 16). Along Lines 2 and 3 in the vicinity of Yucca Mountain the Paleozoic/Tertiary contact produces a reflection signature characterized by a low-frequency, large-magnitude triplet. Because the data were acquired using explosion (impulsive) sources, and the vibrator data was filtered to match the other data, we picked the Paleozoic/Tertiary contact at the top of this reflector triplet.

Lower Crust

As previously described, discontinuous subhorizontal lower-crustal reflections beneath about 15 km (5 s twtt) can be seen only on the southwestern end of Line 2 (St. 101 to 600; fig. 18). These reflections can be observed on shot records obtained using both vibrator and deep shot hole sources. No reflections from the lower crust can be observed northeast of Red Cone (St. 600) on this section, which was confirmed after analysis of the deep shot hole data. The abrupt loss of lower-crustal reflections northeast of Red Cone (St. 600) does not appear to be real. We believe that near-surface conditions in Crater Flat and Yucca Mountain precluded the observation of lower-crustal energy, even from the deep shot hole sources. The water table is over 500 m (1800 ft) deep at Yucca Mountain, and it appears that the seismic energy was lost to due to poor source coupling. The water table in the Amargosa Desert is significantly more shallow than near Yucca Mountain, allowing us to place the shot holes there at or near the water table.

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Line 3

Line 3 ran nearly normal to the predominantly north-trending structures across the potential repository area of Yucca Mountain eastward into Jackass Flats (fig. 1B). This line images a number of reflections at depths as shallow as 1600 ft to as great as 20,000 ft (6.1 km or 3 s twtt) below datum (fig. 17). In general, however, few coherent events are observed below 3 s twtt (fig. 11). Our discussion is divided into sections for Yucca Mountain, Jackass Flats, and the lower crust.

Yucca Mountain (St. 101 to 375)

As does Line 2, Line 3 discontinuously images a low-frequency reflection about 500 m (0.4 s or 1600 ft) below the surface between Yucca Crest and Fran Ridge (St. 160 and 400; fig. 17). VSP data at USW H-6 (St. 101), at USW WT-2 (St. 168), at USW H-4 (projected 1.1 km from the north to St. 240), and at UE-25 p#1 (St. 337) indicate that this reflection is at or near the top of the Prow Pass Tuff of the Crater Flat Group (Table 11). Discontinuities in this event make it difficult to determine fault offset. Within the resolution of the seismic data (several meters) little if any offset of this horizon is noted at the vicinity of the Ghost Dance fault, where much less than 30 m of vertical offset has been mapped at the surface where crossed by the seismic line [Scott and Bonk, 1984; Spengler and others, 1993, 1994; Simonds and others, in press]. Ground magnetic anomaly data, which are sensitive to offset of the Topopah Spring Tuff, apparently show much less offset at the Ghost Dance fault than at the Solitario Canyon fault (fig. 22). It is difficult to determine the offset of this reflection across the Bow Ridge and Midway Valley faults. Both of these regions appear to be complexly faulted zones and have been mapped as imbricate fault zones by Scott [1990], although tunneling results suggest the region near the Bow Ridge fault is not complexly faulted [R.W. Spengler, written commun., 1995].

A second reflection is mapped discontinuously at approximately 2100 to 1800 m depth (1.7 to 1.6 s twtt below datum) between the Ghost Dance fault and Jackass Flats (St. 210 and 510; fig. 17). We interpret this prominent event as the Paleozoic/Tertiary contact based on its high-amplitude, low-frequency signature, structural discordance with overlying reflections, and favorable tie to similar low-frequency reflections along Line 2. This interpretation is strengthened by UE-25 p#1 (St. 337), which intersects this horizon at 1200 m (4000 ft) depth subsurface (0.8 s; Table 11; fig. 9), as well as by density models for the gravity data (fig. 21). We interpret several faults offsetting the Paleozoic/Tertiary contact (fig. 17), although broadly speaking most of these offsets are relatively minor (less than 150 m), in agreement with density models for Line 3 (fig. 21) east of the Bow Ridge. For clarity, several of the faults offsetting this contact are shown as extending upwards into the Tertiary section (fig. 17) even though the seismic data do not show offset of a Tertiary reflector. The largest offset of the inferred Paleozoic/Tertiary contact is less than 500 m. The westerly dip of the top of the Paleozoic section in the density models west of

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Bow Ridge is not evident in the seismic reflection data. Note that both density models in Figure 21 fit the gravity data equally well, showing that gravity data alone are not sensitive to the difference between models A and B. Given the presence of only two reflection events, there is considerable uncertainty in the geometry of the interpreted faults shown in Figure 17.

Perhaps the most unusual and unexpected reflection observed during our survey is a moderately east-dipping event that is imaged directly beneath the western flank of Yucca Mountain (stations 121-181), at 1000 to 2000 m (3300 to 6600 ft; 1.0 to 1.8 s twtt) below datum. This event is well above the top of the inferred Paleozoic basement judging from Line 2 and the gravity data (fig. 21). This large-amplitude reflection was imaged using a reasonable stacking velocity of 13,000 ft/s (fig. 8B), but is not observed on Line 2. We therefore interpret this event as representing either a diffraction which has not been properly collapsed during migration, possibly because it is located at the start of the line, or as side swipe from structure outside the plane of the reflection survey. Less plausibly, it may provide evidence for a block of Tertiary rocks rotated by faults in the vicinity of the Solitario Canyon and Ghost Dance faults, and its large structural discordance could be viewed as evidence for listric faulting in this region, probably pre-Prow Pass tuff, as the Prow Pass Tuff reflector is not involved in this tilting. If the reflection represents a processing artifact, however, the need for listric faulting of the pre-Prow Pass tuff would be eliminated. There is no evidence for such a structure in the surficial geologic mapping.

The rocks beneath the inferred Paleozoic/Tertiary boundary produce a number of reflections along Line 3. They show a variety of dips but the reflections are short and are difficult to interpret. This observation is consistent with our expectation that few coherent reflections within the complexly deformed Paleozoic rocks might be obtained.

Jackass Flats (St. 375 to 541)

Jackass Flats is underlain by a series of shallow, gently east-dipping, continuous, high-frequency reflections. We interpret these events as reflections from the Tertiary fill which define an eastward-thickening Tertiary basin section up to 300 m (800 ft) thick. Minor offsets of these reflections may be noted near the eastern end of the line (at St. 515).

Reflections from the inferred Paleozoic/Tertiary contact at 1800 m (1.6 s) below datum show a number of structures extending nearly to the eastern end of the line. The largest structure lies just east of the Paintbrush Canyon fault. Presuming the line is orthogonal to the structure, we interpret the up to 600 m of apparent offset of the Paleozoic/Tertiary contact there as evidence for a moderate-angle, west-dipping fault which projects upward to the vicinity of Fortymile Wash (St. 451). If Line 3 crossed the fault obliquely, however, the dip of the fault would be steeper than inferred here. In the vicinity of Fortymile Wash the Paleozoic/Tertiary contact has a gentle synclinal structure, and we interpret an offset, down-to-the-east, of 90 m in the Paleozoic/Tertiary contact near Fortymile Wash (fig. 17). Previously acquired gravity and magnetic anomaly data are

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consistent with the absence of larger (hundreds of meters) structural relief of the Paleozoic/Tertiary contact beneath Fortymile Wash [Ponce and others, 1992]. The absence of larger offset of the inferred Paleozoic/Tertiary contact in the vicinity of Fortymile Wash is also consistent with gravity and magnetic data acquired along Line 3 which show no significant anomaly there (figs. 21 and 22). The interpretation of a relatively flat Paleozoic/Tertiary contact beneath Jackass Flats, coupled with an eastward-thickening Tertiary basin, is consistent with an eastward thinning of the Miocene volcanic section.

Lower Crust

Neither the deep shot hole nor vibrator data successfully imaged the lower crust (5 to 10 s twtt) along Line 3. No reflection events below 6000 m (20,000 ft; 3.1 s twtt) can be identified in the section for Line 3. Almost all of the deep shot holes along Line 3 were acquired in ideal weather conditions (Table 6), suggesting that the failure to observe lower-crustal reflections results from unfavorable near-surface geology. As for the eastern parts of Line 2, the shot holes were detonated more than 400 m above the water table, which may have resulted in poor shot coupling and poor signal propagation. Larger shot holes are necessary to obtain lower crustal data in this location.

DISCUSSION

Yucca Mountain offers many challenges to acquiring high-quality seismic reflection data, and early attempts to do so met with little success [McGovern and Turner, 1983]. Lines 2 and 3 were therefore designed to test modern seismic reflection methods at Yucca Mountain. As stated previously, the objectives of this profiling included (1) tracking the pre-Tertiary/Tertiary boundary beneath Yucca Mountain, (2) mapping reflections above this horizon if possible, (3) determining the geometry of faults in the subsurface, and (4) providing subsurface data to limit the number of structural models for Yucca Mountain. A subsidiary objective was to look for seismic bright spots that could indicate the presence of potential magma chambers in the middle and lower crust. Fair- to good-quality data were obtained during our survey in Crater Flat and Jackass Flats, but useful data, although lower in quality, were also obtained at Yucca Mountain. Lines 2 and 3 intersect about 600 m east of the crest of Yucca Mountain, and in that location, both lines show reflections from at or near the top of the Prow Pass Tuff of the Crater Flat Group as well as from the inferred Paleozoic/Tertiary contact (figs. 16 and 17). (The two lines intersect at Station 1027 on Line 2 and Station 191 on Line 3.) The close match is important, as it indicates success in meeting the first two objectives on both lines. Furthermore, as Poulter charges were used to acquire Line 2 in that region whereas vibrator sources were used to acquire the corresponding part of Line 3, the close match suggests that our use of hybrid seismic sources, demanded by environmental,

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topographic, and operational constraints, did in fact provide comparable seismic data along the lines.

The offset of the inferred Paleozoic/Tertiary contact beneath Yucca Mountain is compelling evidence against the presence of an active detachment surface near or at the Paleozoic/Tertiary contact as previously proposed [Scott, 1986, 1990; Fox and Carr, 1989]. Although there is some uncertainty of the dip of the moderate- to high-angle faults which offset this contact along Lines 2 and 3, the clear offset of this surface suggests that the faults extend deeper into the crust as suggested by opponents of the shallow detachment hypothesis [e.g., Carr and others, 1986; Hamilton, written commun., 1994; Fridrich, written commun., 1995].

The age of shallow structures in the vicinity of the Ghost Dance fault is of major concern to evaluation of the potential repository site at Yucca Mountain. Coupling the lack of large offset of the reflection inferred to represent the top of the Prow Pass Tuff with the absence of large surficial offsets in the vicinity of the Ghost Dance fault [Spengler and others, 1993, 1994; Simonds and others, in press], we infer that the large offset of the Paleozoic/Tertiary contact in the vicinity of the Ghost Dance fault formed primarily before the mid-Miocene. Fridrich [written commun., 1995] has documented a large extensional event in Paleozoic and older rocks at Bare Mountain between 18 and 15.2 Ma, which may have extended to Yucca Mountain.

The subsurface geometry of the Bare Mountain range-front fault has similarly been the subject of a long and important debate. The Bare Mountain fault forms the western boundary of the Amargosa Basin structural trough [Wright, 1989; Carr, 1990], and is a major structural feature. Snyder and Carr [1984] modeled the fault as a western boundary of a mid-Miocene caldera, having a steep, easterly dip of 75°. Oliver and Fox [1993] showed that a shallow-dipping (27°) normal fault model is consistent with the gravity data from Crater Flat. Recently, Langenheim [1995] demonstrated that gravity data are consistent with either (1) a low-angle normal fault, (2) stepped, moderate-angle (45°) normal faults, or (3) a single, moderate-angle (45°) fault with interbedding of high-density alluvium in Crater Flat basin. In part, the variability of these estimates of the dip of the fault appear to reflect the progressive decrease in dip of the fault to the north [Hamilton, written commun., 1994; Fridrich, written commun., 1995]. Results from Line 2, which crosses the fault in a location where it dips most steeply [Hamilton, written commun., 1994], are consistent with the Bare Mountain fault representing a single, moderate-angle (42°) fault to a depth of about 3.5 to 3.8 km and inconsistent with its interpretation as a low-angle detachment fault as suggested by Oliver and Fox [1993] and Hamilton [1988]. The moderate dip inferred for the Bare Mountain fault is consistent with other Basin and Range faults, including the Dixie Valley fault of central Nevada [Okaya and Thompson, 1985].

As suggested by surface mapping by Faulds and others [1994], Line 2 clearly shows that the Tertiary strata beneath southwestern Crater Flat dip westward [Hamilton, written commun., 1994].

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Line 2 provides the first subsurface confirmation of these geometrical relations and confirms previous inferences that this portion of Crater Flat underwent the most extension.

Significant contrasts are observed in the eastern and western halves of Crater Flat crossed by Line 2. Northeast of the Crater Flat fault (St. 730), Line 2 is interpreted to show small-scale repeated faulting across Crater Flat and Yucca Mountain. This interpretation is consistent with the disrupted nature of reflectors in this half of Line 2 (fig. 16), with the short-wavelength magnetic anomalies observed there (fig. 20), and with geologic mapping of numerous faults (Crater Flat, Windy Wash, Fatigue Wash, Solitario Canyon, and Ghost Dance faults). Whereas the western half of Crater Flat is generally characterized by low-wavelength magnetic anomalies (apart from high-amplitude anomalies produced by surficial and shallowly buried basaltic flows), its eastern half has a more disrupted magnetic anomaly field (fig. 20).

Strong, shallow reflections observed between Little Cones and Red Cone are thought to correlate to shallow basalt flows. If so, the lack of significant offset on them suggests that this portion of Crater Flat has experienced little faulting since the emplacement of the flows between 11 and 3.7 Ma. No genetic association between Little Cones, Red Cone, and the reflectors can be inferred given their likely age differences [Vaniman and others, 1982].

Lines 2 and 3 also provide important new information on the nature and location of the eastern boundary of the Amargosa Desert structural trough at the latitude of the potential repository site (fig. 1A). The eastern boundary of this structural trough has been previously placed at the eastern end of Line 3 [Brocher and others, 1993] or further east of Line 3 at the Gravity Fault [Hamilton, written commun., 1994; Fridrich, written commun., 1995]. Based on the location of the largest vertical offset of the Paleozoic/Tertiary contact, however, we concur with Carr [1990] that the eastern boundary of the Amargosa Desert structural trough at the latitude of the potential repository site is a diffuse structure extending from the Solitario Canyon fault on the west to the Paintbrush Canyon fault on the east.

Line AV-1 successfully imaged the lower crust (5 to 10 s twtt) along the entire line using both vibrator and deep shot hole sources. Line 2 was similarly successful in imaging the lower crust, but only in the Amargosa Desert and the westernmost part of Crater Flat (fig. 18). In this location, the top of the reflective lower crust is at 4.8 s. The top of the reflective lower crust is commonly interpreted as the top of the ductile lower crust [e.g., Klemperer, 1987; Goodwin and Thompson, 1988], and thus may represent the depth at which high-angle faults merge into pure shear of the lower crust as proposed by Hamilton [written commun., 1994]. The base of the crust, the Moho, is inferred to be between 9 and 10 seconds, implying that the crust is in the vicinity of 27 to 30 km thick. This crustal thickness is identical to that found along Line AV-1 [Brocher and others, 1993], suggestive of a relatively flat Moho in the vicinity of Yucca Mountain. Neither vibrator nor shot hole sources, however, were successful in imaging the lower crust beneath Yucca Mountain or in Jackass Flats. Due to the failure to obtain lower crustal reflections along most of

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Lines 2 and 3, it is not possible to make definitive statements about the presence or absence of magma within or at the base of the crust.

Using VSPs at several wells along Lines 2 and 3 we identified a reflection event at 500 m (0.4 s) beneath Yucca Mountain within the Tertiary volcanic section as within or near the top of the Prow Pass Tuff. The northeastern end of Line 2 was located in the vicinity of the 2-km-long shallow Line 1 acquired by the Lawrence Berkeley Laboratory (LBL) in 1993 [Daley and others, 1994]. LBL Line 1 trended west to east between USW WT-2 and UE-25 UZ-16 (in the vicinity of Stations 1054 and 1088 of Line 2), and crossed the Ghost Dance fault. LBL Line 1 apparently imaged a number of reflection events in the uppermost 1200 m (4000 ft) of the section, including events from a unit of the Prow Pass Tuff at about 460 m (1500 ft) and a unit of the Bullfrog Tuff at about 600 m (2000 ft) [Daley and others, 1994] . The apparent difference in the depth of units mapped within the Prow Pass Tuff (500 m on our Line 2 versus 460 m on LBL-1) probably results from the higher-frequency source used on the LBL line. Reflections from stratified rocks are interference phenomena and are sensitive to the frequency content of the source. Thus the two sources most likely mapped different units with the Prow Pass Tuff. The Prow Pass Tuff thus appears to have been imaged by both reflection surveys, each having different acquisition parameters.

Based on the results of our work we offer the following recommendations for future intermediate-depth seismic reflection profiling in the immediate vicinity of Yucca Mountain. Our work, conducted using standard 2-D parameters, indicates that although Yucca Mountain itself is a difficult area in which to acquire high-quality seismic reflection data, useful data can be obtained. These parameters appeared to work well in Crater Flat and in Jackass Flats, yet they did not work as well in the immediate vicinity of Yucca Mountain itself. Based on the data we acquired for shallow targets such as the Paleozoic/Tertiary contact near Yucca Mountain, we recommend the use of shorter group intervals, in the range of 30 to 40 ft, to provide higher fold in the depths of interest. For similar reasons, source-point intervals should be shortened to 60 or 80 ft. The total spread length may be shortened to the range of 3 to 4 km to each side. Using 2-D geophone group arrays may cancel some of the side scatter produced by the numerous fractures and normal faults. Larger explosions, perhaps in the range of 1000 to 2000 lbs, are necessary to image the lower crust near Yucca Mountain where the water table is 1800 ft deep. A separate statics crew may be necessary to determine accurate static solutions.

On the basis of the encouraging results from this study, results from the seismic industry, and the complex geology at Yucca Mountain, we recommend that 3-D seismic data be acquired in the vicinity of Yucca Mountain to more accurately determine structure. Although the 3-D data will not be of high quality, it will have higher quality than the 2-D data due to the ability to remove side scatter from the 3-D images. Industry has repeatedly shown that 3-D seismic data can improve data quality in difficult acquisition areas such as Yucca Mountain [Horvath, 1985; Schimunek and

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Strobl, 1985; Yilmaz, 1987, p. 385-389]. Poulter charges should be examined as a possible source for the 3-D data acquisition, due to the ability to use the method throughout the survey area, regardless of topography and access to roads. Further field testing of different Poulter sources is recommended, given the limited field trials attempted during our study. Furthermore, Poulter-charge sources are susceptible to high winds and will require some allowance for halting data acquisition during high winds.

CONCLUSIONS

Regional seismic reflection lines obtained using hybrid sources across the Amargosa Desert, Crater Flat, Yucca Mountain, and Jackass Flats provide useful images of upper crustal structure. Although the seismic reflection data are not high in quality, they provide very useful images of the subsurface near Yucca Mountain. Reflections are correlated to Tertiary volcanic formations and the Paleozoic/Tertiary boundary based on geologic mapping, wells along the lines, and auxiliary geophysical models. Offsets of the Paleozoic/Tertiary contact beneath Yucca Mountain suggest that moderate- to high-angle faults mapped at the surface penetrate the Paleozoic/Tertiary contact, providing compelling evidence against the hypothesis of an active shallow detachment surface beneath Yucca Mountain [Scott, 1986, 1990; Fox and Carr, 1989]. Reflections clearly define an asymmetric fault-bounded basin in Crater Flat, up to 3.5 to 4 km thick, extending beneath the western flank of Yucca Mountain. Moderately (42°) east-dipping reflections northeast of Bare Mountain truncate a series of west-dipping reflections, and based on density models, represent a series of normal faults including the Bare Mountain range-front fault. Tertiary strata within the thickest part of the Crater Flat basin dip westward, as recently proposed on the basis of field mapping [Faulds and others, 1994]. These units are overlain by shallow, thin basalt flows having little or no offset and a gentle westward dip, probably corresponding to flows dated at either 11 or 3.7 Ma. Several hundred meters of down-to-the-west offset of the Paleozoic/Tertiary contact is observed beneath Yucca Mountain along Line 2. A mid-Miocene horizon under Yucca Mountain, probably the Prow Pass Tuff of the Crater Flat Group, exhibits much less significant structural relief than the inferred Paleozoic/Tertiary contact and is subparallel to surface topography. Most of the offset on the Paleozoic/Tertiary contact across these faults is inferred to have occurred prior to the mid-Miocene (pre-Prow Pass Tuff), based on the apparent continuity of mid-Miocene units above the inferred faults, and may have formed during an extensional event from 18 to 15.2 Ma preserved in Paleozoic and older rocks at Bare Mountain [Fridrich, written commun., 1995]. Reflection Line 2 demonstrates that the Neogene fill in the Amargosa Desert is thin and floored at shallow depth by Paleozoic and older rocks as previously proposed on the basis of gravity data [Hamilton, written commun.,

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1994]. Likewise, Line 3 indicates that Jackass Flats contains a thin veneer of east-dipping Neogene sedimentary strata. Better interpretation of the seismic reflection data will require additional deep boreholes along the seismic reflection lines. In particular, deep boreholes sampling the Paleozoic/Tertiary contact are necessary to test the interpretations presented here.

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APPENDIX 1. Northern Geophysical of America Crew 110

Name	Title
Stephen John Solokis	Field Supervisor
Michael J. Waugh	Party Manager
Michael L. Allred	Assistant Party Manager
Michael Fitz Maurice	Environmental Health and Safety Manager
Kim Wegemeyer	Safety Coordinator and Assistant Party Manager, Shooter
John F. James	Field Service Engineer
Troy McLeod	Observer
Dan Malberg	Observer, Shooter
Jason T. Clark	Junior Observer, Shooter
Bruce Tankersly	Electronic Technician
William W. Everett	Electronic Technician
Joe Montee	Mechanic
Steve March	Mechanic
Louise Sandberg	Permit Agent
Greg Brooks	Head Linesman
Randall J. Stamey	Linesman, Shooter
Oliver Amend	Shooter
Jon Spuhler	Truck Driver
Wayne Eckersley	Truck Driver
Jeff Loveless	Truck Driver
Randy Fortin	Crew Boss, Shooter
George Berela	Crew Boss, Shooter
Ray Trafelet	Layout Technician
Mike McNamee	Layout Technician
Jeremy Buckham	Layout Technician
Allen Burnnett	Layout Technician
Douglas Pagel	Layout Technician
Schuyler Schaff	Layout Technician
Keith Kepp	Cable Technician
Stuart McCarron	Cable Technician
Dennis Hurst	Cable Technician
John Paoli	Cable Technician
Mike Daugherty	Cable Technician
Carl Beck	Cable Repair Technician
Dennis Maliszewski	Assistant Cable Repair Technician
Caryn Ludwick	Clerk

Northern Geophysical of America Crew 110 Subcontractors

Alpha Explosives

Randy Dale Ladd	Explosives Handler

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APPENDIX 1. Continued.

American Helicopter Drilling, Inc.

Name	Title
Murray Lee Duffy	Supervisor, Minihole Driller
Brian Scott Adams	Minihole Driller
Gregory Brian Bonnifield	Minihole Driller
William Henry Chesser	Minihole Driller
Bret H. Mace	Minihole Driller
Peter William Reck	Minihole Driller
Walter Bailey Wilson	Minihole Driller

Extreme Surveys, Inc.

Benjamin Thomas Cullen III	Surveyor
Neil Alan Neumeyer	Surveyor
William Joseph Wayland	Rodman

Pacific Western Helicopters

Darrel Eugene Stubbs	Pilot
Thomas Alan Wilson	Mechanic

Trace Ventures Exploration

Brian John Ahorner	Vibrator Mechanic
Gilbert Matta Pallan	Lead Vibrator Operator
Ramon Marquez Aguilar	Vibrator Operator
Jesus Matta Lujan	Vibrator Operator
Jose Luis Lujan Jr.	Vibrator Operator

Geophysical Control, Inc.

John Christopher Tonish	Field Data Processor

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APPENDIX 2. Field Instrumentation Used by Northern Geophysical of America Crew 110

I/O System Two

1) Correlator Stacker Module - Serial No. 4288 (Boards MCU, INT, MTL, SWP, 4-CNE's, 3-SMX)
2) System Control Module - Serial No. 24 (Boards PI, PF, TFB, TC, DL, FP, MCC, INT, SMX, MCU)
3) Line Interface Module - Serial No. 23 (Boards LRX, AIX, ACX, TO, LSX, SRX, GCX, LAT, ARB, INT, SMX, MCU)
4) Tape Transport (9-track tape drive) - Serial No. 6688
5) OYO Geospace DFM 480 Digital Field Monitor - Serial NO. 99500-0200
6) Princeton Color Monitor
7) Two Computer Key Boards - Serial No. 1496116 and 069-1F
8) I/O System Random Computer SN 22372
9) HHT Unit - Serial No. 135495
10) Full Set of I/O System, StorageTek, and DFM480 manuals
11) Tool Chest with Parts for Radios and Cabling for the I/O System

12) 100 RSX (Cable Boxes) Units
13) 695 sets of 24 geophones - Geospace 20D's - 10 Hz

Power Supplies

14) Power Inverters SN F0328, F0346
15) Power One D.C. Power Supplies - SN CE61002013, SN CE61002013
16) Jet Power Supply - Serial No. 9336048361
17) 12 Volt RV Batteries Witch Power System
18) 12 Kilowatt Onan
19) Line Stabilizer/Conditioner

Vibrator Electronics

20) COMPAQ Desk Pro 386/33L for Pelton Vibrator Display - Serial No. 4133HAS30541
21) Pelton Advance II Encoder - Serial No. 50E218
22) Compaq 4/25 CS Lap Top Computer - Serial No. 7311HDW20149
23) Panasonic KX-P2123 Dot Matrix Printer - Serial No. 3FCSBNE02125
24) Full set of Pelton manuals

Blasting Systems

25) Macha International, Inc. (Shot Blasting System) Encoders SN 108312, SN 108313
26) Macha International, Inc. Shooting System SN 108314, M-1

Magnetic Tapes

27) 150 Indel-Davis Precision Magnetic 9-track Tapes

Miscellaneous Trucks and Vehicles

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APPENDIX 2. Continued.

Northern Geophysical of America Subcontractors

Alpha Explosives

100 and 200 lb shots	VIBROGEL	300 ft blasting cap Model Electric Super
Minihole shots	UNIMAX	Electric Super blasting cap
Poulter shots	SURF-A-SEIS	10 grain/ft Primacord, Electric Super blasting caps

American Helicopter Drilling, Inc.

People Portable Drill PT-A100 manufactured by American Helicopter Drilling

Extreme Surveys, Inc.

1) Topcon GTS-302 Serial No. CK0694
2) 200 ft fiberglass chain
3) 25 ft telescoping rod
4) Advance Positioning's SEISURV Software System Release 3.6

Pacific Western Helicopters

Trace Ventures Exploration

Mertz Model 18 Buggy and Pelton Advanced 2, Version 5.0, Electronics

Vibrator	Vib. Serial No.	Pelton Serial No.
1	83061094	510852
2	83061095	510853
3	83061096	510854
4	83061097	510850

Litton LRS Truck

Vibrator	Vib. Serial No.	Pelton Serial No.
5	315-9-4758	510851

Geophysical Control, Inc.

1) MicroMAX 2.01 Software Release from Advance Geophysical - Serial No. A010153
2) Compaq ProSignia CPU - Serial No. 6333HFU10397
3) STC 2925 9 Track Tape Drive - Serial No. 6614797
4) OYO GS 612 Thermal Transfer Plotter - Serial No. 99300-355
5) Wyse 700 Monitor - Serial No. 20T1010635

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APPENDIX 3. SURVEY COORDINATES by EXTREME SURVEYS

Line YMP-2

St. No.	Lat. N (Deg. ' ")	Long. W (Deg. ' ")	Nevada Central Zone East. X (ft)	North. Y (ft)	Elev. Z (ft)
101	36 43 1337	116 40 1754	498572	717172	2663
102	36 43 1397	116 40 1686	498628	717233	2663
103	36 43 1457	116 40 1617	498683	717293	2662
104	36 43 1517	116 40 1548	498740	717354	2662
105	36 43 1576	116 40 1478	498797	717413	2663
106	36 43 1635	116 40 1409	498853	717474	2663
107	36 43 1695	116 40 1340	498909	717534	2664
108	36 43 1755	116 40 1271	498966	717594	2665
109	36 43 1814	116 40 1202	499021	717655	2664
110	36 43 1873	116 40 1132	499079	717714	2664
111	36 43 1932	116 40 1061	499136	717773	2664
112	36 43 1991	116 40 0992	499193	717833	2664
113	36 43 2050	116 40 0922	499250	717893	2664
114	36 43 2110	116 40 0853	499305	717953	2665
115	36 43 2170	116 40 0784	499362	718014	2665
116	36 43 2229	116 40 0715	499418	718074	2665
117	36 43 2288	116 40 0645	499475	718134	2664
118	36 43 2348	116 40 0576	499531	718194	2663
119	36 43 2408	116 40 0508	499586	718255	2664
120	36 43 2468	116 40 0440	499642	718316	2664
121	36 43 2527	116 40 0371	499698	718375	2664
122	36 43 2587	116 40 0302	499754	718436	2665
123	36 43 2647	116 40 0233	499810	718497	2665
124	36 43 2707	116 40 0164	499867	718557	2665
125	36 43 2767	116 40 0096	499922	718618	2666
126	36 43 2828	116 40 0028	499977	718679	2666
127	36 43 2888	116 39 5960	500032	718741	2666
128	36 43 2948	116 39 5891	500089	718801	2667
129	36 43 3007	116 39 5822	500145	718861	2667
130	36 43 3068	116 39 5755	500200	718923	2668
131	36 43 3128	116 39 5686	500255	718983	2668
132	36 43 3188	116 39 5617	500311	719044	2668
133	36 43 3249	116 39 5550	500366	719105	2667
134	36 43 3309	116 39 5481	500422	719166	2667
135	36 43 3369	116 39 5414	500477	719227	2667
136	36 43 3429	116 39 5345	500533	719288	2667
137	36 43 3489	116 39 5276	500589	719348	2667
138	36 43 3549	116 39 5208	500645	719409	2667
139	36 43 3609	116 39 5139	500701	719469	2667
140	36 43 3669	116 39 5070	500757	719530	2667
141	36 43 3728	116 39 5001	500813	719590	2668
142	36 43 3788	116 39 4932	500869	719650	2669
143	36 43 3847	116 39 4863	500926	719710	2669
144	36 43 3906	116 39 4794	500982	719770	2670
145	36 43 3966	116 39 4724	501038	719831	2670
146	36 43 4026	116 39 4655	501095	719891	2671
147	36 43 4085	116 39 4586	501151	719951	2671
148	36 43 4145	116 39 4517	501207	720011	2671
149	36 43 4205	116 39 4448	501263	720072	2670
150	36 43 4264	116 39 4379	501320	720132	2670
151	36 43 4323	116 39 4309	501377	720191	2670
152	36 43 4383	116 39 4240	501433	720252	2671
153	36 43 4443	116 39 4172	501488	720313	2672
154	36 43 4501	116 39 4101	501546	720372	2672
155	36 43 4560	116 39 4031	501603	720431	2672
156	36 43 4619	116 39 3961	501660	720491	2672
157	36 43 4675	116 39 3887	501720	720547	2673
158	36 43 4734	116 39 3818	501776	720608	2673
159	36 43 4794	116 39 3749	501833	720667	2673
160	36 43 4853	116 39 3679	501890	720727	2672
161	36 43 4912	116 39 3609	501947	720787	2672
162	36 43 4971	116 39 3539	502003	720847	2672
163	36 43 5032	116 39 3472	502058	720908	2672
164	36 43 5092	116 39 3403	502114	720969	2672
165	36 43 5151	116 39 3334	502170	721029	2671
166	36 43 5212	116 39 3266	502226	721090	2671
167	36 43 5271	116 39 3197	502282	721150	2671
168	36 43 5330	116 39 3127	502339	721210	2671
169	36 43 5389	116 39 3057	502396	721269	2671
170	36 43 5446	116 39 2984	502455	721327	2671
171	36 43 5502	116 39 2912	502514	721384	2671
172	36 43 5560	116 39 2841	502572	721442	2671
173	36 43 5617	116 39 2769	502630	721500	2671
174	36 43 5675	116 39 2697	502689	721558	2671
175	36 43 5732	116 39 2625	502747	721617	2671
176	36 43 5789	116 39 2553	502806	721674	2671
177	36 43 5846	116 39 2480	502865	721732	2671
178	36 43 5902	116 39 2406	502925	721788	2671
179	36 43 5959	116 39 2334	502984	721846	2671
180	36 44 0017	116 39 2263	503041	721905	2671
181	36 44 0074	116 39 2191	503101	721962	2672
182	36 44 0131	116 39 2118	503159	722020	2672
183	36 44 0187	116 39 2045	503219	722076	2672
184	36 44 0244	116 39 1973	503278	722134	2672
185	36 44 0301	116 39 1901	503336	722191	2672
186	36 44 0357	116 39 1828	503396	722249	2673
187	36 44 0414	116 39 1756	503455	722306	2673
188	36 44 0469	116 39 1682	503515	722362	2673
189	36 44 0527	116 39 1610	503574	722420	2673
190	36 44 0583	116 39 1537	503633	722477	2674
191	36 44 0640	116 39 1464	503692	722534	2673
192	36 44 0695	116 39 1390	503752	722591	2674
193	36 44 0753	116 39 1318	503811	722649	2674
194	36 44 0809	116 39 1245	503870	722706	2675
195	36 44 0866	116 39 1172	503930	722763	2676
196	36 44 0922	116 39 1099	503989	722820	2677
197	36 44 0979	116 39 1026	504048	722878	2677
198	36 44 1039	116 39 0957	504105	722938	2678
199	36 44 1098	116 39 0887	504162	722998	2676
200	36 44 1158	116 39 0819	504217	723058	2675
201	36 44 1218	116 39 0750	504273	723119	2676
202	36 44 1278	116 39 0682	504328	723180	2675
203	36 44 1338	116 39 0613	504385	723240	2675
204	36 44 1398	116 39 0545	504440	723301	2676
205	36 44 1456	116 39 0475	504497	723360	2676
206	36 44 1516	116 39 0405	504554	723421	2676
207	36 44 1575	116 39 0336	504610	723480	2675
208	36 44 1635	116 39 0267	504667	723541	2676
209	36 44 1694	116 39 0197	504723	723601	2675
210	36 44 1753	116 39 0127	504780	723660	2675
211	36 44 1812	116 39 0058	504837	723720	2676
212	36 44 1872	116 38 5988	504893	723780	2676
213	36 44 1929	116 38 5917	504951	723839	2677
214	36 44 1990	116 38 5849	505007	723900	2676
215	36 44 2050	116 38 5780	505062	723960	2676
216	36 44 2109	116 38 5710	505119	724020	2676
217	36 44 2168	116 38 5641	505176	724080	2677
218	36 44 2226	116 38 5570	505234	724139	2677
219	36 44 2284	116 38 5499	505291	724197	2678
220	36 44 2342	116 38 5427	505350	724256	2677
221	36 44 2400	116 38 5356	505408	724314	2677

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222	36 44 2452	116 38 5277	505471	724367	2677
223	36 44 2507	116 38 5204	505531	724423	2678
224	36 44 2560	116 38 5124	505596	724476	2678
225	36 44 2616	116 38 5057	505651	724533	2677
226	36 44 2675	116 38 4986	505709	724592	2677
227	36 44 2731	116 38 4913	505768	724650	2679
228	36 44 2788	116 38 4840	505827	724707	2680
229	36 44 2844	116 38 4766	505888	724763	2681
230	36 44 2897	116 38 4689	505950	724817	2682
231	36 44 2943	116 38 4605	506019	724864	2684
232	36 44 2983	116 38 4516	506091	724904	2685
233	36 44 3010	116 38 4421	506169	724931	2686
234	36 44 3060	116 38 4339	506235	724983	2687
235	36 44 3102	116 38 4252	506306	725024	2690
236	36 44 3134	116 38 4158	506382	725057	2689
237	36 44 3186	116 38 4080	506446	725109	2691
238	36 44 3243	116 38 4009	506504	725167	2692
239	36 44 3302	116 38 3939	506560	725227	2693
240	36 44 3363	116 38 3872	506615	725289	2696
241	36 44 3425	116 38 3806	506668	725351	2697
242	36 44 3489	116 38 3744	506719	725416	2699
243	36 44 3553	116 38 3683	506769	725481	2701
244	36 44 3619	116 38 3623	506817	725547	2703
245	36 44 3670	116 38 3546	506880	725599	2705
246	36 44 3743	116 38 3500	506918	725673	2707
247	36 44 3815	116 38 3453	506956	725746	2709
248	36 44 3889	116 38 3410	506991	725821	2712
249	36 44 3963	116 38 3367	507026	725896	2713
250	36 44 4037	116 38 3324	507061	725970	2716
251	36 44 4111	116 38 3280	507097	726045	2718
252	36 44 4185	116 38 3238	507131	726120	2720
253	36 44 4258	116 38 3194	507166	726194	2723
254	36 44 4332	116 38 3152	507201	726269	2725
255	36 44 4406	116 38 3107	507237	726344	2727
256	36 44 4480	116 38 3064	507272	726418	2730
257	36 44 4554	116 38 3021	507307	726493	2732
258	36 44 4628	116 38 2979	507342	726568	2735
259	36 44 4702	116 38 2938	507375	726643	2738
260	36 44 4774	116 38 2891	507413	726716	2740
261	36 44 4848	116 38 2848	507448	726791	2741
262	36 44 4922	116 38 2803	507484	726865	2744
263	36 44 4996	116 38 2761	507519	726940	2747
264	36 44 5069	116 38 2718	507554	727015	2750
265	36 44 5144	116 38 2675	507589	727090	2752
266	36 44 5217	116 38 2631	507625	727164	2755
267	36 44 5291	116 38 2587	507660	727238	2758
268	36 44 5364	116 38 2543	507696	727312	2761
269	36 44 5437	116 38 2500	507731	727387	2764
270	36 44 5511	116 38 2457	507766	727461	2767
271	36 44 5586	116 38 2415	507800	727537	2769
272	36 44 5658	116 38 2368	507838	727610	2772
273	36 44 5731	116 38 2324	507875	727684	2776
274	36 44 5805	116 38 2281	507910	727758	2779
275	36 44 5878	116 38 2238	507945	727833	2783
276	36 44 5952	116 38 2194	507980	727907	2786
277	36 45 0026	116 38 2150	508016	727982	2789
278	36 45 0099	116 38 2107	508051	728056	2792
279	36 45 0173	116 38 2064	508086	728131	2795
280	36 45 0247	116 38 2021	508121	728206	2798
281	36 45 0321	116 38 1978	508156	728280	2801
282	36 45 0395	116 38 1934	508191	728355	2803
283	36 45 0468	116 38 1891	508226	728429	2806
284	36 45 0541	116 38 1846	508263	728503	2807
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1065	36 50 2024	116 27 0504	562993	760409	4308
1066	36 50 2057	116 27 0416	563064	760443	4277
1067	36 50 2065	116 27 0323	563139	760450	4248
1068	36 50 2077	116 27 0230	563215	760463	4220
1069	36 50 2090	116 27 0136	563292	760476	4192
1070	36 50 2104	116 27 0043	563367	760490	4165
1071	36 50 2116	116 26 5948	563444	760503	4138
1072	36 50 2129	116 26 5853	563521	760516	4114
1073	36 50 2143	116 26 5754	563602	760531	4103
1074	36 50 2155	116 26 5653	563684	760543	4097
1075	36 50 2169	116 26 5553	563765	760557	4090
1076	36 50 2182	116 26 5453	563846	760571	4094
1077	36 50 2196	116 26 5355	563926	760585	4101
1078	36 50 2209	116 26 5253	564009	760598	4105
1079	36 50 2224	116 26 5154	564089	760614	4107
1080	36 50 2238	116 26 5054	564170	760628	4106
1081	36 50 2253	116 26 4955	564251	760643	4098
1082	36 50 2268	116 26 4856	564331	760659	4087
1083	36 50 2283	116 26 4758	564411	760674	4071
1084	36 50 2298	116 26 4661	564490	760689	4053
1085	36 50 2312	116 26 4564	564569	760704	4035
1086	36 50 2325	116 26 4467	564647	760717	4020
1087	36 50 2339	116 26 4367	564729	760731	4015
1088	36 50 2353	116 26 4268	564809	760745	4008
1089	36 50 2366	116 26 4168	564890	760759	4007
1090	36 50 2381	116 26 4069	564971	760774	4006
1091	36 50 2396	116 26 3969	565052	760790	4002
1092	36 50 2410	116 26 3870	565133	760805	4001
1093	36 50 2424	116 26 3770	565214	760818	4000
1094	36 50 2440	116 26 3670	565295	760835	3997
1095	36 50 2456	116 26 3570	565376	760852	3995
1096	36 50 2471	116 26 3473	565456	760866	4006
1097	36 50 2482	116 26 3376	565534	760878	4028
1098	36 50 2495	116 26 3280	565612	760891	4050
1099	36 50 2507	116 26 3182	565691	760904	4070
1100	36 50 2521	116 26 3084	565771	760918	4088
1101	36 50 2536	116 26 2986	565851	760933	4101
1102	36 50 2551	116 26 2887	565932	760949	4111
1103	36 50 2575	116 26 2792	566008	760973	4101
1104	36 50 2608	116 26 2707	566078	761007	4070
1105	36 50 2640	116 26 2622	566146	761039	4040
1106	36 50 2671	116 26 2538	566214	761071	4006
1107	36 50 2703	116 26 2454	566283	761104	3969
1108	36 50 2735	116 26 2372	566350	761135	3936
1109	36 50 2767	116 26 2285	566420	761168	3912
1110	36 50 2801	116 26 2195	566493	761203	3896
1111	36 50 2837	116 26 2105	566566	761239	3889
1112	36 50 2872	116 26 2013	566641	761275	3888
1113	36 50 2909	116 26 1923	566714	761312	3881
1114	36 50 2943	116 26 1832	566788	761348	3871
1115	36 50 2979	116 26 1742	566861	761384	3859
1116	36 50 3014	116 26 1652	566934	761420	3843
1117	36 50 3049	116 26 1561	567008	761455	3832
1118	36 50 3083	116 26 1469	567083	761489	3824
1119	36 50 3118	116 26 1377	567157	761525	3824
1120	36 50 3153	116 26 1286	567231	761561	3820
1121	36 50 3188	116 26 1195	567305	761596	3816
1122	36 50 3223	116 26 1103	567380	761632	3812
1123	36 50 3257	116 26 1011	567454	761667	3808
1124	36 50 3293	116 26 0919	567529	761702	3808
1125	36 50 3327	116 26 0827	567604	761737	3804
1126	36 50 3362	116 26 0736	567678	761772	3801
1127	36 50 3397	116 26 0644	567752	761808	3797
1128	36 50 3432	116 26 0551	567828	761844	3793
1129	36 50 3468	116 26 0459	567902	761880	3789
1130	36 50 3503	116 26 0368	567977	761916	3785
1131	36 50 3538	116 26 0276	568052	761951	3781
1132	36 50 3572	116 26 0184	568126	761987	3777
1133	36 50 3607	116 26 0093	568200	762022	3779

Line YMP-2 Source Locations

SP No.	Lat. N (Deg. ' ")	Long. W (Deg. ' ")	Nevada Central Zone East. X (ft)	North. Y (ft)	Elev. Z (ft)
1	36 43 1386	116 40 1820	498518	717221	2663
3	36 43 5936	116 39 2329	502988	721822	2671
5	36 44 4634	116 38 2943	507371	726574	2736

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7	36	45	2912	116	37	3369	511905	730902	2953
9	36	45	5891	116	36	3086	517016	733917	2939
11	36	46	3142	116	35	2107	522691	737209	2999
13	36	47	0403	116	34	1138	528358	740511	3062
201	36	47	3664	116	33	0164	534026	743815	3173
203	36	48	0824	116	31	5058	539801	747018	3364
205A	36	48	4072	116	30	4111	545445	750311	3574
205	36	48	3950	116	30	4254	545329	750187	3574
205B	36	48	4187	116	30	3973	545558	750427	3575
207	36	49	1570	116	29	3316	550965	753858	3783
208.5B	36	49	5221	116	28	2170	556767	757561	4243
208.5	36	49	5222	116	28	2202	556741	757562	4240
208.5A	36	49	5219	116	28	2135	556795	757559	4249
211A	36	50	2248	116	26	5806	563560	760637	4109
211B	36	50	2282	116	26	5850	563523	760671	4113

St. No.	Lat. N (Deg. ' ")	Long. W (Deg. ' ")	Nevada Central Zone East X (ft)	North Y (ft)	Elev. Z (ft)
975	36 49 5169	116 28 2757	556290	757507	4181
976	36 49 5175	116 28 2641	556385	757514	4190
977	36 49 5183	116 28 2520	556483	757522	4200
978	36 49 5192	116 28 2409	556573	757532	4213
979	36 49 5201	116 28 2296	556665	757540	4226
981	36 49 5217	116 28 2062	556855	757558	4261
982	36 49 5225	116 28 1964	556934	757566	4278
1075	36 50 2110	116 26 5524	563789	760498	4087
1076	36 50 2063	116 26 5392	563897	760451	4077
1077	36 50 2021	116 26 5253	564009	760408	4069
1078	36 50 1999	116 26 5154	564090	760386	4062
1079	36 50 1982	116 26 4992	564221	760369	4052
1080	36 50 1982	116 26 4884	564309	760370	4045
1081	36 50 1985	116 26 4793	564383	760372	4039
1082	36 50 1986	116 26 4680	564475	760374	4030
1083	36 50 1989	116 26 4573	564562	760377	4022
1084	36 50 1991	116 26 4400	564703	760379	4011
1085	36 50 2122	116 26 4423	564684	760512	4015
1087	36 50 2428	116 26 4390	564710	760821	4018
1089	36 50 2335	116 26 4158	564899	760728	4003
1090	36 50 2275	116 26 4036	564998	760668	3996
1091	36 50 2230	116 26 3944	565073	760622	3992
1092	36 50 2168	116 26 3821	565173	760560	3984

Line YMP-3

St. No.	Lat N (Deg ' ")	Long W (Deg ' ")	Nevada Central Zone East X (ft)	North Y (ft)	Elev Z (ft)
101	36 50 4834	116 28 5474	554070	763232	4271
102	36 50 4797	116 28 5383	554144	763195	4267
103	36 50 4767	116 28 5289	554220	763164	4258
104	36 50 4738	116 28 5194	554297	763135	4251
105	36 50 4708	116 28 5100	554374	763105	4247
106	36 50 4674	116 28 5008	554449	763071	4243
107	36 50 4639	116 28 4916	554524	763035	4239
108	36 50 4603	116 28 4824	554598	763000	4232
109	36 50 4567	116 28 4734	554672	762963	4228
110	36 50 4529	116 28 4644	554745	762925	4222
111	36 50 4490	116 28 4554	554818	762885	4219
112	36 50 4453	116 28 4464	554892	762849	4214
113	36 50 4411	116 28 4378	554962	762806	4208
114	36 50 4365	116 28 4293	555031	762760	4204
115	36 50 4323	116 28 4206	555101	762717	4201
116	36 50 4279	116 28 4121	555171	762672	4197
117	36 50 4231	116 28 4039	555237	762625	4193
118	36 50 4180	116 28 3961	555301	762573	4188
119	36 50 4127	116 28 3883	555365	762519	4184
120	36 50 4070	116 28 3810	555424	762462	4180
121	36 50 4018	116 28 3732	555487	762409	4176
122	36 50 3963	116 28 3657	555548	762354	4172
123	36 50 3907	116 28 3583	555609	762298	4168
124	36 50 3850	116 28 3511	555667	762240	4164
125	36 50 3790	116 28 3443	555723	762179	4161
126	36 50 3726	116 28 3379	555775	762114	4156
127	36 50 3669	116 28 3307	555834	762057	4148
128	36 50 3615	116 28 3231	555895	762003	4145
129	36 50 3562	116 28 3154	555958	761949	4141
130	36 50 3508	116 28 3077	556021	761894	4138
131	36 50 3453	116 28 3000	556084	761840	4136
132	36 50 3399	116 28 2923	556146	761784	4135
133	36 50 3345	116 28 2848	556208	761731	4132
134	36 50 3292	116 28 2771	556270	761677	4146
135	36 50 3240	116 28 2696	556332	761624	4153
136	36 50 3186	116 28 2619	556394	761570	4163
137	36 50 3133	116 28 2542	556457	761516	4169
138	36 50 3078	116 28 2466	556518	761461	4177
139	36 50 3025	116 28 2389	556581	761407	4185
140	36 50 2970	116 28 2313	556643	761352	4195
141	36 50 2916	116 28 2236	556705	761297	4209
142	36 50 2861	116 28 2161	556767	761242	4227
143	36 50 2807	116 28 2084	556829	761187	4244
144	36 50 2752	116 28 2010	556890	761132	4255
145	36 50 2698	116 28 1933	556953	761077	4266
146	36 50 2644	116 28 1856	557015	761023	4282
147	36 50 2590	116 28 1780	557077	760968	4301
148	36 50 2535	116 28 1705	557138	760913	4331
149	36 50 2480	116 28 1630	557199	760857	4355
150	36 50 2424	116 28 1555	557261	760801	4379
151	36 50 2368	116 28 1481	557321	760745	4404
152	36 50 2312	116 28 1406	557382	760688	4435
153	36 50 2257	116 28 1333	557441	760632	4466
154	36 50 2201	116 28 1258	557502	760576	4509
155	36 50 2144	116 28 1184	557563	760519	4562
156	36 50 2087	116 28 1110	557623	760461	4608
157	36 50 2031	116 28 1038	557681	760404	4670
158	36 50 1974	116 28 0964	557741	760347	4728
159	36 50 1915	116 28 0891	557801	760288	4780
160	36 50 1859	116 28 0817	557861	760231	4827
161	36 50 1803	116 28 0744	557921	760175	4869
162	36 50 1747	116 28 0670	557981	760118	4908
163	36 50 1692	116 28 0595	558042	760062	4950
164	36 50 1651	116 28 0507	558114	760021	4944
165	36 50 1631	116 28 0408	558194	760001	4937
166	36 50 1578	116 28 0331	558257	759948	4928
167	36 50 1553	116 28 0236	558335	759923	4916
168	36 50 1531	116 28 0140	558413	759900	4904
169	36 50 1501	116 28 0046	558489	759871	4892
170	36 50 1460	116 27 5959	558559	759829	4881
171	36 50 1414	116 27 5878	558626	759782	4868
172	36 50 1388	116 27 5785	558701	759757	4848
173	36 50 1362	116 27 5692	558777	759730	4828
174	36 50 1336	116 27 5599	558853	759704	4809
175	36 50 1310	116 27 5504	558930	759678	4797
176	36 50 1282	116 27 5409	559007	759650	4781
177	36 50 1256	116 27 5315	559083	759624	4765
178	36 50 1229	116 27 5222	559159	759596	4748
179	36 50 1201	116 27 5126	559237	759569	4737

180	36	50	1175	116	27	5031	559315	759542	4730
181	36	50	1149	116	27	4935	559393	759517	4724
182	36	50	1123	116	27	4839	559471	759490	4718
183	36	50	1097	116	27	4743	559549	759464	4711
184	36	50	1071	116	27	4648	559626	759438	4702
185	36	50	1045	116	27	4553	559703	759412	4695
186	36	50	1018	116	27	4456	559782	759385	4689
187	36	50	0992	116	27	4361	559860	759359	4682
188	36	50	0966	116	27	4265	559938	759332	4677
189	36	50	0941	116	27	4169	560016	759307	4670
190	36	50	0915	116	27	4074	560093	759281	4661
191	36	50	0888	116	27	3978	560171	759254	4651
192	36	50	0863	116	27	3883	560248	759229	4640
193	36	50	0836	116	27	3787	560326	759202	4632
194	36	50	0813	116	27	3690	560405	759179	4622
195	36	50	0790	116	27	3594	560484	759156	4610
196	36	50	0767	116	27	3497	560562	759133	4597
197	36	50	0742	116	27	3402	560640	759107	4583
198	36	50	0716	116	27	3307	560717	759081	4569
199	36	50	0692	116	27	3212	560794	759057	4555
200	36	50	0665	116	27	3117	560871	759030	4538
201	36	50	0639	116	27	3023	560948	759004	4523
202	36	50	0614	116	27	2928	561025	758979	4507
203	36	50	0587	116	27	2837	561100	758952	4492
204	36	50	0562	116	27	2740	561178	758927	4474
205	36	50	0540	116	27	2644	561256	758904	4471
206	36	50	0512	116	27	2546	561336	758876	4453
207	36	50	0505	116	27	2450	561414	758869	4447
208	36	50	0465	116	27	2362	561485	758829	4437
209	36	50	0429	116	27	2272	561559	758793	4426
210	36	50	0407	116	27	2177	561636	758770	4418
211	36	50	0393	116	27	2078	561717	758757	4406
212	36	50	0377	116	27	1980	561797	758741	4391
213	36	50	0361	116	27	1882	561876	758725	4378
214	36	50	0342	116	27	1785	561955	758705	4365
215	36	50	0309	116	27	1693	562030	758672	4356
216	36	50	0277	116	27	1600	562105	758640	4347
217	36	50	0243	116	27	1510	562179	758606	4339
218	36	50	0210	116	27	1417	562254	758573	4332
219	36	50	0173	116	27	1328	562327	758536	4324
220	36	50	0127	116	27	1245	[illegible]	758490	431[illegible]
221	36	50	0065	116	27	1182	562446	758426	4306
222	36	49	5992	116	27	1136	562484	758353	4300
223	36	49	5927	116	27	1076	562532	758287	4304
224	36	49	5863	116	27	1012	562584	758223	4303
225	36	49	5801	116	27	0948	562637	758160	4296
226	36	49	5750	116	27	0869	562701	758109	4286
227	36	49	5710	116	27	0781	562772	758069	4275
228	36	49	5695	116	27	0682	562853	758054	4270
229	36	49	5684	116	27	0583	562934	758042	4257
230	36	49	5672	116	27	0486	563012	758031	4235
231	36	49	5662	116	27	0391	563090	758021	4210
232	36	49	5652	116	27	0296	563167	758011	4181
233	36	49	5643	116	27	0196	563248	758001	4177
234	36	49	5633	116	27	0096	563329	757992	4191
235	36	49	5623	116	26	5997	563410	757982	4208
236	36	49	5613	116	26	5899	563490	757972	4226
237	36	49	5602	116	26	5800	563570	757961	4242
238	36	49	5592	116	26	5700	563651	757952	4256
239	36	49	5581	116	26	5601	563732	757940	4272
240	36	49	5572	116	26	5502	563812	757932	4290
241	36	49	5563	116	26	5404	563892	757922	4310
242	36	49	5553	116	26	5304	563973	757913	4320
243	36	49	5542	116	26	5204	564055	757902	4324
244	36	49	5529	116	26	5105	564136	757889	4318
245	36	49	5516	116	26	5007	564216	757876	4303
246	36	49	5503	116	26	4909	564295	757863	4283
247	36	49	5490	116	26	4813	564373	757849	4260
248	36	49	5477	116	26	4717	564451	757837	4236
249	36	49	5465	116	26	4622	564529	757825	4211
250	36	49	5455	116	26	4526	564606	757814	4182
251	36	49	5443	116	26	4431	564684	757803	4155
252	36	49	5431	116	26	4332	564764	757791	4144
253	36	49	5420	116	26	4234	564844	757780	4166
254	36	49	5406	116	26	4135	564924	757766	4187
255	36	49	5393	116	26	4037	565004	757753	4206
256	36	49	5380	116	26	3937	565085	757740	4222
257	36	49	5367	116	26	3838	565166	757727	4231
258	36	49	5353	116	26	3737	565248	757714	4228
259	36	49	5336	116	26	3639	565328	757696	4220
260	36	49	5319	116	26	3541	565408	757679	4208
261	36	49	5301	116	26	3442	565488	757662	4197
262	36	49	5284	116	26	3344	565568	757644	4186
263	36	49	5268	116	26	3247	565647	757628	4174
264	36	49	5251	116	26	3148	565727	757611	4162
265	36	49	5234	116	26	3050	565807	757594	4147
266	36	49	5218	116	26	2954	565885	757578	4126
267	36	49	5203	116	26	2858	565963	757563	4103
268	36	49	5187	116	26	2764	566040	757547	4079
269	36	49	5172	116	26	2669	566117	757532	4055
270	36	49	5156	116	26	2574	566194	757516	4032
271	36	49	5141	116	26	2478	566272	757501	4008
272	36	49	5125	116	26	2382	566350	757485	3985
273	36	49	5109	116	26	2287	566427	757469	3962
274	36	49	5092	116	26	2192	566504	757453	3938
275	36	49	5077	116	26	2096	566582	757437	3917
276	36	49	5061	116	26	1999	566662	757421	3897
277	36	49	5044	116	26	1902	566740	757404	3883
278	36	49	5026	116	26	1805	566820	757387	3870
279	36	49	5011	116	26	1706	566900	757371	3861
280	36	49	4994	116	26	1607	566980	757354	3850
281	36	49	4978	116	26	1509	567060	757338	3841
282	36	49	4961	116	26	1410	567141	757321	3828
283	36	49	4944	116	26	1311	567221	757304	3825
284	36	49	4927	116	26	1211	567302	757287	3819
285	36	49	4912	116	26	1111	567384	757272	3816
286	36	49	4894	116	26	1012	567464	757255	3811
287	36	49	4878	116	26	0914	567544	757238	3806
288	36	49	4862	116	26	0814	567625	757222	3799
289	36	49	4845	116	26	0715	567706	757205	379[illegible]
290	36	49	4828	116	26	0616	567786	757188	3788
291	36	49	4811	116	26	0517	567867	757171	3784
292	36	49	4794	116	26	0417	567948	757155	3780
293	36	49	4778	116	26	0317	568029	757138	3774
294	36	49	4761	116	26	0218	568110	757121	3768
295	36	49	4744	116	26	0118	568191	757104	3762
296	36	49	4728	116	26	0019	568272	757088	3758
297	36	49	4711	116	25	5921	568352	757071	3754
298	36	49	4694	116	25	5820	568433	757055	3748
299	36	49	4678	116	25	5722	568514	757038	3748
300	36	49	4662	116	25	5622	568595	757022	3746
301	36	49	4643	116	25	5524	568675	757004	3765
302	36	49	4626	116	25	5427	568754	756986	3786
303	36	49	4610	116	25	5329	568833	756971	3804
304	36	49	4595	116	25	5230	568914	756955	3807
305	36	49	4572	116	25	5134	568992	756932	3794
306	36	49	4549	116	25	5038	569070	756909	3777
307	36	49	4526	116	25	4942	569148	756886	3756
308	36	49	4503	116	25	4846	569226	756863	3743
309	36	49	4480	116	25	4749	569305	756840	3734
310	36	49	4456	116	25	4652	569384	756816	3728
311	36	49	4432	116	25	4555	569463	756792	3723

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312	36	49	4408	116	25	4457	569543	756768	3714
313	36	49	4385	116	25	4359	569622	756745	3714
314	36	49	4362	116	25	4261	569702	756721	3713
315	36	49	4338	116	25	4164	569781	756697	3709
316	36	49	4314	116	25	4068	569859	756674	3704
317	36	49	4291	116	25	3970	569939	756651	3702
318	36	49	4268	116	25	3874	570017	756627	3698
319	36	49	4244	116	25	3777	570096	756604	3694
320	36	49	4221	116	25	3679	570175	756580	3691
321	36	49	4197	116	25	3582	570255	756556	3688
322	36	49	4173	116	25	3485	570334	756532	3684
323	36	49	4150	116	25	3389	570412	756509	3681
324	36	49	4127	116	25	3292	570490	756486	3679
325	36	49	4103	116	25	3195	570569	756462	3676
326	36	49	4079	116	25	3097	570649	756438	3674
327	36	49	4055	116	25	3002	570727	756414	3672
328	36	49	4031	116	25	2905	570806	756390	3668
329	36	49	4007	116	25	2808	570885	756366	3666
330	36	49	3983	116	25	2711	570963	756342	3662
331	36	49	3959	116	25	2614	571042	756318	3660
332	36	49	3935	116	25	2517	571121	756294	3657
333	36	49	3912	116	25	2420	571200	756270	3656
334	36	49	3889	116	25	2323	571278	756247	3655
335	36	49	3861	116	25	2228	571356	756220	3655
336	36	49	3838	116	25	2131	571435	756196	3655
337	36	49	3814	116	25	2033	571514	756172	3654
338	36	49	3791	116	25	1936	571593	756149	3660
339	36	49	3768	116	25	1839	571673	756126	3669
340	36	49	3745	116	25	1743	571751	756102	3679
341	36	49	3721	116	25	1645	571830	756079	3687
342	36	49	3697	116	25	1548	571909	756055	3693
343	36	49	3673	116	25	1452	571988	756031	3696
344	36	49	3649	116	25	1354	572067	756007	3697
345	36	49	3625	116	25	1258	572146	755982	3691
346	36	49	3602	116	25	1160	572225	755959	3680
347	36	49	3578	116	25	1064	572303	755935	3689
348	36	49	3553	116	25	0966	572383	755910	3689
349	36	49	3529	116	25	0869	572461	755887	3698
350	36	49	3505	116	25	0773	572540	755862	3705
351	36	49	3480	116	25	0676	572619	755838	3711
352	36	49	3456	116	25	0579	572698	755813	3716
353	36	49	3433	116	25	0484	572775	755790	3723
354	36	49	3409	116	25	0388	572853	755766	3713
355	36	49	3385	116	25	0291	572932	755742	3738
356	36	49	3360	116	25	0194	573011	755717	3758
357	36	49	3336	116	25	0098	573089	755693	3785
358	36	49	3312	116	25	0002	573167	755669	3814
359	36	49	3288	116	24	5905	573246	755645	3842
360	36	49	3263	116	24	5808	573325	755620	3867
361	36	49	3239	116	24	5710	573405	755596	3884
362	36	49	3215	116	24	5614	573483	755572	3886
363	36	49	3190	116	24	5516	573562	755547	3877
364	36	49	3164	116	24	5421	573640	755520	3872
365	36	49	3140	116	24	5323	573720	755497	3881
366	36	49	3116	116	24	5226	573798	755472	3894
367	36	49	3092	116	24	5129	573877	755448	3902
368	36	49	3067	116	24	5033	573956	755423	3911
369	36	49	3045	116	24	4935	574035	755401	3913
370	36	49	3036	116	24	4834	574118	755393	3903
371	36	49	3028	116	24	4735	574198	755384	3885
372	36	49	3020	116	24	4638	574277	755377	3863
373	36	49	3012	116	24	4542	574355	755369	3836
374	36	49	3004	116	24	4445	574434	755361	3812
375	36	49	2995	116	24	4344	574516	755352	3808
376	36	49	2987	116	24	4244	574598	755344	3803
377	36	49	2978	116	24	4144	574679	755335	3798
378	36	49	2969	116	24	4043	574761	755326	3798
379	36	49	2961	116	24	3942	574843	755318	3792
380	36	49	2954	116	24	3842	574925	755311	3781
381	36	49	2947	116	24	3743	575005	755304	3765
382	36	49	2940	116	24	3645	575085	755297	3747
383	36	49	2932	116	24	3546	575165	755290	3729
384	36	49	2925	116	24	3451	575242	755283	3700
385	36	49	2918	116	24	3354	575321	755276	3678
386	36	49	2911	116	24	3258	575399	755269	3653
387	36	49	2904	116	24	3163	575477	755263	3626
388	36	49	2896	116	24	3068	575553	755254	3597
389	36	49	2888	116	24	2971	575632	755246	3573
390	36	49	2879	116	24	2877	575709	755238	3549
391	36	49	2872	116	24	2778	575790	755231	3532
392	36	49	2865	116	24	2680	575869	755224	3517
393	36	49	2858	116	24	2579	575951	755217	3502
394	36	49	2851	116	24	2480	576032	755210	3488
395	36	49	2844	116	24	2380	576113	755204	3477
396	36	49	2836	116	24	2280	576194	755195	3467
397	36	49	2829	116	24	2179	576277	755189	3461
398	36	49	2821	116	24	2078	576359	755181	3457
399	36	49	2815	116	24	1977	576441	755174	3449
400	36	49	2807	116	24	1875	576524	755167	3448
401	36	49	2800	116	24	1774	576606	755160	3443
402	36	49	2792	116	24	1674	576688	755153	3438
403	36	49	2785	116	24	1572	576770	755146	3433
404	36	49	2778	116	24	1472	576852	755138	3431
405	36	49	2770	116	24	1371	576934	755131	3427
406	36	49	2763	116	24	1270	577016	755124	3423
407	36	49	2755	116	24	1169	577098	755116	3420
408	36	49	2748	116	24	1068	577180	755109	3414
409	36	49	2740	116	24	0966	577263	755102	3409
410	36	49	2733	116	24	0865	577345	755095	3408
411	36	49	2726	116	24	0764	577428	755087	3407
412	36	49	2718	116	24	0662	577510	755080	3404
413	36	49	2709	116	24	0561	577592	755071	3396
414	36	49	2702	116	24	0461	577674	755064	3381
415	36	49	2696	116	24	0362	577754	755059	3390
416	36	49	2689	116	24	0268	577831	755052	3361
417	36	49	2685	116	24	0167	577913	755048	3352
418	36	49	2667	116	24	0072	577990	755029	3348
419	36	49	2647	116	23	5974	578070	755009	3345
420	36	49	2626	116	23	5874	578151	754989	3343
421	36	49	2607	116	23	5779	578228	754969	3342
422	36	49	2595	116	23	5680	578309	754958	3360
423	36	49	2585	116	23	5583	578388	754947	3382
424	36	49	2578	116	23	5483	578469	754941	3395
425	36	49	2579	116	23	5382	578551	754942	3396
426	36	49	2574	116	23	5281	578634	754938	3394
427	36	49	2567	116	23	5179	578716	754931	3395
428	36	49	2561	116	23	5078	578798	754925	3387
429	36	49	2553	116	23	4977	578881	754917	3396
430	36	49	2547	116	23	4876	578963	754911	3397
431	36	49	2541	116	23	4775	579045	754905	3397
432	36	49	2536	116	23	4673	579128	754900	3396
433	36	49	2530	116	23	4572	579210	754894	3396
434	36	49	2525	116	23	4473	579290	754890	3384
435	36	49	2521	116	23	4373	579372	754885	3365
436	36	49	2505	116	23	4274	579452	754870	3345
437	36	49	2490	116	23	4176	579532	754855	3345
438	36	49	2476	116	23	4077	579613	754841	3336
439	36	49	2464	116	23	3979	579693	754829	3325
440	36	49	2448	116	23	3880	579773	754813	3322
441	36	49	2432	116	23	3779	579855	754797	3322
442	36	49	2417	116	23	3679	579936	754782	3323
443	36	49	2402	116	23	3579	580018	754768	3323

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444	36 49 2388	116 23 3479	580099	754753	3324
445	36 49 2372	116 23 3379	580180	754737	3324
446	36 49 2358	116 23 3279	580262	754723	3324
447	36 49 2342	116 23 3179	580343	754708	3324
448	36 49 2328	116 23 3080	580424	754693	3324
449	36 49 2312	116 23 2980	580505	754678	3325
450	36 49 2297	116 23 2880	580586	754663	3326
451	36 49 2282	116 23 2781	580667	754648	3325
452	36 49 2268	116 23 2680	580749	754634	3322
453	36 49 2254	116 23 2580	580830	754620	3324
454	36 49 2242	116 23 2481	580911	754608	3343
455	36 49 2234	116 23 2389	580985	754600	3386
456	36 49 2230	116 23 2289	581067	754596	3392
457	36 49 2228	116 23 2189	581148	754594	3392
458	36 49 2224	116 23 2088	581230	754591	3391
459	36 49 2222	116 23 1987	581313	754589	3391
460	36 49 2220	116 23 1884	581396	754587	3391
461	36 49 2217	116 23 1784	581478	754584	3391
462	36 49 2211	116 23 1682	581560	754579	3392
463	36 49 2206	116 23 1581	581643	754574	3394
464	36 49 2199	116 23 1480	581725	754567	3395
465	36 49 2193	116 23 1379	581807	754561	3396
466	36 49 2186	116 23 1278	581889	754554	3398
467	36 49 2180	116 23 1177	581972	754549	3398
468	36 49 2175	116 23 1075	582054	754544	3400
469	36 49 2172	116 23 0973	582137	754540	3400
470	36 49 2167	116 23 0872	582219	754536	3402
471	36 49 2162	116 23 0771	582301	754531	3403
472	36 49 2156	116 23 0670	582383	754525	3404
473	36 49 2151	116 23 0569	582466	754521	3405
474	36 49 2146	116 23 0466	582549	754516	3405
475	36 49 2143	116 23 0365	582631	754513	3406
476	36 49 2137	116 23 0264	582713	754507	3407
477	36 49 2132	116 23 0163	582796	754502	3409
478	36 49 2125	116 23 0061	582878	754496	3410
479	36 49 2120	116 22 5960	582961	754491	3411
480	36 49 2113	116 22 5859	583043	754483	3412
481	36 49 2107	116 22 5758	583125	754478	3413
482	36 49 2098	116 22 5657	583207	754469	3414
483	36 49 2096	116 22 5556	583290	754467	3417
484	36 49 2090	116 22 5454	583372	754462	3419
485	36 49 2090	116 22 5353	583455	754462	3420
486	36 49 2082	116 22 5252	583537	754454	3421
487	36 49 2074	116 22 5150	583619	754446	3423
488	36 49 2066	116 22 5050	583701	754439	3424
489	36 49 2059	116 22 4949	583783	754431	3425
490	36 49 2050	116 22 4848	583865	754423	3426
491	36 49 2043	116 22 4746	583948	754415	3428
492	36 49 2035	116 22 4645	584030	754408	3429
493	36 49 2023	116 22 4545	584112	754396	3430
494	36 49 2012	116 22 4444	584193	754386	3431
495	36 49 2002	116 22 4343	584276	754375	3432
496	36 49 1990	116 22 4243	584357	754363	3434
497	36 49 1977	116 22 4143	584438	754351	3433
498	36 49 1967	116 22 4042	584520	754340	3436
499	36 49 1957	116 22 3941	584602	754330	3437
500	36 49 1947	116 22 3840	584685	754321	3439
501	36 49 1937	116 22 3740	584766	754311	3440
502	36 49 1927	116 22 3639	584848	754301	3441
503	36 49 1917	116 22 3539	584930	754291	3443
504	36 49 1906	116 22 3438	585012	754280	3443
505	36 49 1895	116 22 3337	585094	754270	3444
506	36 49 1885	116 22 3236	585176	754260	3445
507	36 49 1874	116 22 3136	585258	754249	3447
508	36 49 1864	116 22 3035	585340	754239	3449
509	36 49 1854	116 22 2934	585422	754229	3450
510	36 49 1843	116 22 2833	585504	754218	3452
511	36 49 1833	116 22 2733	585586	754208	3452
512	36 49 1822	116 22 2632	585667	754197	3453
513	36 49 1813	116 22 2532	585749	754188	3455
514	36 49 1801	116 22 2431	585831	754177	3456
515	36 49 1790	116 22 2330	585913	754166	3456
516	36 49 1780	116 22 2229	585995	754156	3457
517	36 49 1769	116 22 2129	586077	754145	3460
518	36 49 1759	116 22 2028	586159	754135	3462
519	36 49 1750	116 22 1928	586240	754126	3463
520	36 49 1739	116 22 1827	586322	754116	3464
521	36 49 1729	116 22 1727	586404	754106	3466
522	36 49 1719	116 22 1626	586486	754096	3466
523	36 49 1708	116 22 1525	586568	754085	3469
524	36 49 1698	116 22 1425	586649	754075	3468
525	36 49 1688	116 22 1325	586730	754065	3470
526	36 49 1674	116 22 1223	586814	754051	3472
527	36 49 1663	116 22 1122	586895	754041	3471
528	36 49 1653	116 22 1021	586978	754030	3473
529	36 49 1642	116 22 0921	587059	754020	3474
530	36 49 1631	116 22 0820	587141	754009	3475
531	36 49 1619	116 22 0720	587223	753997	3475
532	36 49 1610	116 22 0618	587306	753988	3476
533	36 49 1597	116 22 0522	587383	753976	3478
534	36 49 1587	116 22 0421	587466	753965	3477
535	36 49 1577	116 22 0321	587547	753955	3477
536	36 49 1566	116 22 0220	587630	753945	3480
537	36 49 1555	116 22 0120	587711	753933	3480
538	36 49 1545	116 22 0020	587792	753924	3482
539	36 49 1533	116 21 5920	587874	753913	3483
540	36 49 1524	116 21 5820	587955	753903	3484
541	36 49 1514	116 21 5715	588040	753893	3487

Line YMP-3 Source Locations

SP No.	Lat N (Deg ' ")	Long W (Deg ' ")	Nevada Central Zone East X (ft)	North Y (ft)	Elev Z (ft)
302A	36 50 3799	116 28 3524	555657	762188	4162
302B	36 50 3756	116 28 3488	555687	762145	4257
305A	36 49 5538	116 27 0174	563266	757895	4153
305B	36 49 5495	116 27 0145	563290	757852	4150
307	36 49 3856	116 25 2733	570946	756213	3662
311	36 49 2727	116 24 0244	577850	755090	3357

St No.	Lat. (Deg ' ")	Long (Deg ' ")	Nevada Central Zone East. X (ft)	North. Y (ft)	Elev Z (ft)
127	36 50 3649	116 28 3325	555819	762037	4151
128	36 50 3576	116 28 3283	555853	761963	4147
129	36 50 3504	116 28 3255	555876	761890	4142
130	36 50 3391	116 28 3219	555905	761776	4135
173	36 50 1308	116 27 5709	558763	759675	4838
175	36 50 1213	116 27 5526	558912	759580	4815
177	36 50 1109	116 27 5332	559070	759475	4788
179	36 50 1067	116 27 5167	559204	759433	4768
181	36 50 1039	116 27 4968	559366	759405	4747
183	36 50 0996	116 27 4769	559528	759362	4729
185	36 50 0959	116 27 4575	559686	759325	4708
187	36 50 0966	116 27 4366	559855	759333	4687
189	36 50 0969	116 27 4158	560025	759335	4668

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191	36	50	0986	116	27	3951	560193	759353	4652	313	36	49	4415	116	25	4355	569625	756775	3714
193	36	50	1026	116	27	3710	560389	759394	4630	314	36	49	4373	116	25	4257	569706	756733	3712
195	36	50	0931	116	27	3545	560523	759298	4609	315	36	49	4362	116	25	4157	569787	756721	3708
197	36	50	0791	116	27	3384	560654	759157	4584	316	36	49	4352	116	25	4060	569866	756712	3704
199	36	50	0676	116	27	3218	560790	759041	4554	317	36	49	4346	116	25	3958	569949	756706	3699
201	36	50	0456	116	27	3039	560935	758819	4511	319	36	49	4327	116	25	3759	570110	756688	3692
206	36	50	0512	116	27	2546	561336	758877	4454	321	36	49	4296	116	25	3564	570269	756656	3688
223	36	49	5904	116	27	1100	562513	758264	4293	323	36	49	4218	116	25	3371	570426	756578	3682
225	36	49	5739	116	27	0993	562600	758098	4271	325	36	49	4129	116	25	3191	570573	756488	3677
227	36	49	5638	116	27	0803	562755	757996	4249	327	36	49	4055	116	25	3001	570727	756413	3672
229	36	49	5472	116	27	0553	562959	757829	4213	329	36	49	3961	116	25	2811	570882	756319	3664
231	36	49	5328	116	27	0407	563078	757683	4191	331	36	49	3880	116	25	2628	571031	756238	3659
233	36	49	5227	116	27	0222	563228	757581	4163	333	36	49	3862	116	25	2425	571196	756220	3656
235	36	49	5416	116	27	0025	563388	757773	4140										
311	36	49	4470	116	25	4541	569474	756831	3714										

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APPENDIX 4. OBSERVERS LOG FOR NOISE TEST

NORTHERN GEOPHYSICAL OF AMERICA
I/O SYSTEM TWO
CREW #110 LINE #2SW - 2 NOISE TEST
YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
CLIENT: U.S.G.S.
10/25/94

//

GENERAL COMMENTS

//

RECORDING PARAMETERS ARE AS FCLLOWS
((I/O SYSTEM TWO))
•••LOWCUT OUT (DEFAULT FILTER (3.0 HZ @ 12db SLOPE)•••
•••HIGHCUT 1/2 NYQUIST MINIMUM PHASE (135 HZ @190 db SLOPE)•••

((PREAMP GAIN'S ARE AT 48db))

(HPE OUT)

INPUT Aux 1 PILOT	Tape Aux 1
INPUT Aux 2 PILOT FLD	Tape Aux 2
INPUT Aux 5 CLOCK	Tape Aux 3
INPUT Aux 12 100 Hz	Tape Aux 5

TAPE FORMAT: SEG-D 4 BYTE, SAMPLE RATE 2 ms

NOTE: WE WILL BE RECORDING 3 LINES LIVE STA #673 - 833.

"SPREAD CONFIGURATION"
NOTE: LINE#1 24 PHONES PLANTED OVER 165 ft INLINE
LINE#2 12 PHONES POTTED IN A 5 ft DIAMETER
LINE#3 24 PHONES IS AS "WEIGHTED" OVER 165 ft INLINE

NOTE: VIB'S ARE MERTZ MODEL 18
SYSTEM IS PELTON ADVANCED 2 5.0
SWEEP TIME TEST LINEAR 0.002 START 0.002 END TAPER
FREQ. TEST

//
//

Reel #01 is monthly test.

Reel #02 is crossfeed & common mode.

I/O SYSTEM TWO OBSERVER report summary

File	Rec.	VIB POINT	Line.From.Thru	Type	SWEEPS	Comments
1	3A	2.0.729.0	1, 727.738	raw	1	WIRE LINE SIM ON 4 VIB'S STA #727 - 736, START OF REEL #03
2	102A	1.0.735.0	1, 813.816	raw	1	GEOPHONE TAP TEST AT STA #814 TAPPING ON TOP OF THE GEOPHONE
3	102A	1.0.752.0	1, 673.833 2, 673.833 3, 673.833	raw	1	NOISE STRIP
4	3A	1.0.752.0	1, 673.833 2, 673.833 3, 673.833	F St C	12	TEST #1

Test #1: At Sta #752: 12 Sweeps, 12 Second Sweeps, 8 Second Listen. 4 vibrators, 8hz To 40hz Centered On The Flag Bumper To Bumper With No Move Up.

5	3A	1.0.752.0	1, 673.833	F St C	12	TEST #2

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2, 673,833
3, 673,833

Test #2: 12 Sweeps, 12 Second Sweeps, 8 Second Listen. 4 vibrators, 12hz To 80hz Centered On The Flag Bumper To Bumper With No Move Up.

6 3A 1.0,752.0 1, 673,833 F St C 12 TEST #3
2, 673,833
3, 673,833

Test #3: 12 Sweeps, 6 Second Sweeps, 8 Second Listen. 4 vibrators, 10hz To 50hz Centered On The Flag Bumper To Bumper No Move Up.
NOTE: STA #1,821 WENT OPEN.

7 3A 1.0,752.0 1, 673,833 F St C 12 TEST #4
2, 673,833
3, 673,833

Test #4: 12 Sweeps, 8 Second Sweeps, 8 Second Listen. 4 vibrators, 10hz To 50hz Centered On The Flag Bumper To Bumper No Move Up.

8 3A 1.0,752.0 1, 673,833 F St C 12 VOID FILE
2, 673,833
3, 673,833

9 3A 1.0,752.0 1, 673,833 F St C 12 TEST #5
2, 673,833
3, 673,833

Test #5: 12 Sweeps, 12 Second Sweeps, 8 Second Listen. 4 vibrators, 10hz To 50hz Centered On The Flag Bumper To Bumper No Move Up.
NOTE: THIS VP IS ON STA #751.

10 3A 1.0,752.0 1, 673,833 F St C 12 TEST #6
2, 673,833
3, 673,833

Test #6: 12 Sweeps, 12 Second Sweeps, 8 Second Listen. 4 vibrators, 10hz To 50hz Centered On The Flag 7.2 ft Move Up Covering 165 ft 2 Sweeps At Each Location 6 Move Up's Total.

11 3A 1.0,752.0 1, 673,833 F St C 12 TEST #7, END OF REEL #03 (2 X EOF)
2, 673,833
3, 673,833

Test #7: 12 Sweeps, 12 Second Sweeps, 8 Second Listen. 4 vibrators, 10hz To 50hz Centered On The Flag 8 ft Move Up Covering 225 ft 11 Move Up's Total.

12 4A 1.0,672.0 1, 673,833 F St C 12 TEST #8, START OF REEL #04
2, 673,833
3, 673,833

Test #8: New Location Sta. 672. 12 Sweeps, 12 Second Sweeps, 8 Second Listen. 4 vibrators, 10hz To 50hz Centered On The Flag 8 ft Move Up Covering 225 ft 11 Move Up's Total..

13 4A 1.0,672.0 1, 673,833 F St C 12 TEST #9
2, 673,833
3, 673,833

Test #9: 12 Sweeps, 12 Second Sweeps, 8 Second Listen. 4 vibrators, 10hz To 50hz Centered On The Flag 7.2 ft Move Up Covering 165 ft 2 Sweep's At Each Location 6 Move Up's Total.

14 4A 1.0,672.0 1, 673,833 F St C 12 TEST #10
2, 673,833
3, 673,833

Test #10: 12 Sweeps, 12 Second Sweeps, 8 Second Listen. 4 vibrators, 8hz To 40hz Centered On The Flag No Move Up.

15 4A 1.0,672.0 1, 673,833 F St C 12 TEST #11
2, 673,833
3, 673,833

Test #11: 12 Sweeps, 12 Second Sweeps, 8 Second Listen. 4 vibrators, 12hz To 80hz Centered On The Flag No Move Up.

16 4A 1.0,672.0 1, 673,833 F St C 6 TEST #12
2, 673,833
3, 673,833

Test #12: 6 Sweeps, 12 Second Sweeps, 8 Second Listen. 4 vibrators, 10hz To 50hz Centered On The Flag No Move Up.

17 4A 1.0,672.0 1, 673,833 F St C 8 TEST #13
2, 673,833
3, 673,833

Test #13: 8 sweeps, 12 second sweeps, 8 second listen. 4 vibrators, 10hz to 50hz centered on the flag no move-up.

18 4A 1.0,672.0 1, 673,833 F St C 10 TEST #14
2, 673,833
3, 673,833

Test #14: 10 sweeps, 12 second sweeps, 8 second listen. 4 vibrators, 10hz to 50hz centered on the flag no move-up.

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19 4A 1.0,652.0 1, 673,833 F St C 12 TEST #15
2, 673,833
3, 673,833

Test #15: New location sta #652: 12 sweeps, 12 second sweeps, 8 second listen. 4 vibrators, 10hz to 50hz centered on the flag 8 ft move-up 11 times total distance 225 ft.

20 4A 1.0,652.0 1, 673,833 F St C 12 TEST #16, END OF REEL #04 (2 X EOF)
2, 673,833
3, 673,833

Test #16. 12 sweeps, 12 second sweeps, 8 second listen. 4 vibrators, 10hz to 50hz centered on the flag 7.2 ft move-up 5 times total distance 165 ft. Shake 2 times then move.

NOTE: START OF NEW DAY 10/26/94.
I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	Line,From,Thru	Type	SWEEPS	Comments
21	5A	1.0,754.0	2, 754,754	raw	1	Transformer test at sta #2,754, start of reel #05

NOTE: DAILY TEST FILES 9015 - 9128.

22 5A 1.0,752.0 1, 673,833 raw 1 NOISE STRIP
2, 673,833
3, 673,833

23 5A 1.0,752.0 1, 673,833 raw 1 TEST #17, 40lbs over 165 ft poulter shot, sta #2,754 is shorted
2, 673,833
3, 673,833

24 5A 1.0,752.0 1, 673,833 raw 1 TEST #18, 40lbs OVER 82.5 ft POULTER SHOT
2, 673,833
3, 673,833

21 5A 1.0,754.0 2, 751,762 raw 1 Wire line sim on 4 vibrators, should be file 25, the system reset file.

22 5A 1.0,752.0 1, 673,833 F St C 12 TEST #19, Should be file#26, sta #2,759 went open
2, 673,833
3, 673,833

Test #19 : 12 sweeps, 12 second sweeps, 8 second listen. 4 vibrators, 12hz to 70hz centered on the flag 7.2 ft move-up 5 times total distance 165 ft. Shake 2 times then move.

*****THE SYSTEM RESET THERE WILL BE NO FILES 25 & 26.

27 5A 1.0,752.0 1, 673,833 F St C 12 TEST #20
2, 673,833
3, 673,833

Test #20: 1^ sweeps, 18 second sweeps, 8 second listen. 4 vibrators, 10hz to 50hz centered on the flag no move-up.

28 5A 1.0,752.0 1, 673,833 F St C 12 TEST #21, Sta #2,759 is fixed now
2, 673,833
3, 673,833

Test #21: 12 sweeps, 24 second sweeps, 8 second listen. 4 vibrators, 10hz to 50hz centered on the flag no move-up.

29 5A 1.0,834.0 1, 673,833 F St C 12 TEST #22
2, 673,833
3, 673,833

Test #22: 12 sweeps, 12 second sweeps, 8 second listen. 4 vibrators, 10hz to 50hz centered on the flag moving 8 ft 11 times 225 ft pattern

30 5A 1.0,834.0 1, 673,833 F St C 12 TEST #23
2, 673,833
3, 673,833

Test #23: 12 sweeps, 12 second sweeps, 8 second listen. 4 vibrators, 10hz to 50hz centered on the flag moving 7.2 ft 5 times 165 ft pattern

31 5A 1.0,834.0 1, 673,833 F St C 12 TEST #24,END OF REEL #05 (2 X EOD)
2, 673,833
3, 673,833

Test #24: 12 sweeps, 12 second sweeps, 8 second listen. 4 vibrators, 10hz to 50hz centered on the flag no move-up.
NOTE: THIS IS THE LAST TEST ON 2SW-2.

End of OBSERVER data.

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APPENDIX 5. OBSERVERS LOG FOR LINE 2 & 2SW

NORTHERN GEOPHYSICAL OF AMERICA
I/O SYSTEM TWO
CREW #110, LINE #2SW - 2
YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
CLIENT: U.S. Geological Survey
11/04/94

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GENERAL COMMENTS

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RECORDING PARAMETERS ARE AS FOLLOWS
((I/O SYSTEM TWO))
•••LOWCUT OUT (DEFAULT FILTER (3.0 HZ @ 12db SLOPE)•••
•••HIGHCUT 1/2 NYQUIST MINIMUM PHASE (135 HZ @190 db SLOPE)•••

((PREAMP GAIN'S))
ARE AT 48db

(HPE OUT)
(VIBROSEIS AUX'S)

INPUT Aux 1 PILOT	Tape Aux 1
INPUT Aux 2 PILOT FLD	Tape Aux 2
INPUT Aux 5 CLOCK	Tape Aux 3
INPUT Aux 12 100 hz	Tape Aux 4

(DOWNHOLE EXPLOSIVES AUX'S)

INPUT Aux 5 CLOCK T.B.	Tape Aux 1
INPUT Aux 6 CONFIRMATION T.B.	Tape Aux 2
INPUT Aux 9 ANALOG UPHOLE	Tape Aux 3
INPUT Aux 11 NOTHING	Tape Aux 4
INPUT Aux 12 100 hz	Tape Aux 5

(POULTER SHOT SURFACE SEIS EXPLOSIVES)

INPUT Aux 5 CLOCK T.B.	Tape Aux 1
INPUT Aux 6 CONFIRMATION T.B.	Tape Aux 2
INPUT Aux 11	Tape Aux 3
INPUT Aux 12 100 hz	Tape Aux 4

TAPE FORMAT: SEG-D 4 BYTE, SAMPLE RATE 2ms

NOTE: LINE SHOT FROM B.O.L. (101) TO E.O.L. (1133). LINE STARTED WITH 241 CHANNELS LIVE ROLLING INTO A FULL SPLIT OF 240/240 ENDED WITH 241 CHANNELS LIVE. THERE ARE 481 CHANNELS TOTAL.

NOTE: WE WILL BE RECORDING THE ONE STATION GAP FOR THE LINE UPHOLE.

"SPREAD CONFIGURATION"
24 GEOPHONES PLANTED INLINE OVER 165 ft
GEOPHONES ARE GEOSPACE 20 D'S 10hz

NOTE:VIB'S ARE MERTZ MODEL 18 SYSTEM ARE PELTON ADVANCED 2 5.0
WE WILL USE 10-50hz LINEAR 12-12 SEC SWEEPS.

NOTE: WE WILL ALSO BE USING POULTER SHOT DYNAMITE,40 LBS OF OF SURFACE-SIZE EXPLOSIVES OVER 82.5FT

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NOTE: WE WILL USE DOWNHOLE EXPLOSIVES, 200 LB. CHARGE AT 200 ft., 100 LB. CHARGE AT 100 ft.

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NOTE: The Following Stations Are Near Roads Or Have Some Other Types Of Ambient Noise.

STA # 101 - 343 RUNS DOWN A ROAD
STA # 235 IS OPEN FOR HYWAY 95
STA # 430 ROAD
STA # 530 - 560 LINE BENDS TO SOUTH OF HILL.
STA # 575 ROAD
STA # 645-945 RUNS DOWN A ROAD
STA # 1031 ROAD
STA # 1000 TOP OF YUCCA MTN.
STA # 1074 ROAD
STA # 1088 ROAD
STA # 1127 ROAD
STA # 1133 E.O.L.

NOTE: THE FOLLOWING STATIONS ARE STACKED FOR ELEVATION CHANGE.

STA # 997 OVER 50 ft
STA # 998 OVER 60 ft
STA # 999 OVER 40 ft
STA # 1000 OVER 150 ft
STA # 1001 OVER 125 ft
STA # 1002 OVER 120 ft
STA # 1003 OVER 100 ft
STA # 1004 OVER 75 ft
STA # 1005 - 1008 OVER 80 ft
STA # 1009 OVER 140 ft
STA # 1010 - 1031 OVER 165 ft
STA # 1032 - 1042 OVER 85 ft
STA # 1043 - 1063 OVER 165 ft
STA # 1064 - 1070 OVER 85 ft
STA # 1071 - 1095 OVER 165 ft
STA # 1096 - 1100 OVER 85 ft
STA # 1101 - 1103 OVER 165 ft
STA # 1104 - 1108 OVER 85 ft
STA # 1109 - 1133 OVER 165 ft

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NOTE: FFID 1 IS START OF NEW DAY 10/27/94.
I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
1	6A	2.0,101.0	2,101	2,342	raw	1	NOISE STRIP, START OF NEW REEL #06
2	6A	2.0,101.0	2,101	2,342	F. Stk	12	
3	6A	2.0,105.0	2,101	2,346	F. Stk	12	
4	6A	2.0,109.0	2,101	2,350	F. Stk	12	
5	6A	2.0,113.0	2,101	2,354	F. Stk	12	
6	6A	2.0,117.0	2,101	2,358	F. Stk	12	
7	6A	2.0,121.0	2,101	2,362	F. Stk	12	
8	6A	2.0,125.0	2,101	2,366	F. Stk	12	
9	6A	2.0,129.0	2,101	2,370	F. Stk	12	
10	6A	2.0,133.0	2,101	2,374	F. Stk	12	
11	6A	2.0,137.0	2,101	2,378	F. Stk	12	END OF REEL #06 (2 X EOF)

NOTE: DAILY TEST FILES 9015 - 9128.

12	7A	2.0,141.0	2,101	2,382	F. Stk	12	START OF NEW REEL #07
13	7A	2.0,145.0	2,101	2,386	F. Stk	12	

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14	7A	2.0,149.0	2,101	2,390	F. Stk	12	
15	7A	2.0,153.0	2,101	2,394	F. Stk	12	
16	7A	2.0,157.0	2,101	2,398	F. Stk	12	
18	7A	2.0,161.0	2,101	2,402	F. Stk	12	
19	7A	2.0,165.0	2,101	2,406	F. Stk	12	END OF REEL #07 (2 X EOF)

NOTE: FFID 19 IS THE LAST VP OF THE DAY 10/27/94.

NOTE: DAILY TEST ARE ON REEL #08 FILES 9015 - 9128.

NOTE: FFID 20 IS START OF NEW DAY 10/28/94.

20	9A	2 0,169.0	2,101	2,410	raw	1	NOISE STRIP, START OF REEL #09
21	9A	2.0,169.0	2,101	2,410	F. Stk	12	FIRST VP OF THE DAY
01	9A	2.0,173.0	2,101	2,414	F. Stk	12	The system reset to file #01, should be file#22
23	9A	2.0,177.0	2,101	2,418	F. Stk	12	
24	9A	2.0,181.0	2,101	2,422	F. Stk	12	
25	9A	2.0,185.0	2,101	2,426	F. Stk	12	
26	9A	2.0,189.0	2,101	2,430	F. Stk	12	
27	9A	2.0,193.0	2,101	2,434	F. Stk	12	
28	9A	2.0,197.0	2,101	2,438	F. Stk	12	
29	9A	2.0,201.0	2,101	2,442	F. Stk	12	
30	9A	2.0,205.0	2,101	2,446	F. Stk	12	
31	9A	2.0,209.0	2,101	2,450	F. Stk	12	END OF REEL #09 (2 X EOF)

I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
32	10A	2.0,213.0	2,101	2,454	F. Stk	12	START OF REEL #10
33	10A	2.0,217.0	2,101	2,458	F. Stk	12	
34	10A	2.0,221.0	2,101	2,461	F. Stk	12	

NOTE: The far trace (channel) forward is one trace too many for a 240/240 split so we have adjusted for this at this vp.
NOTE: FROM THE VP STATION THERE IS 240 LIVE CHANNELS FRONT AND BACK WHEN WE ARE AT A FULL SPLIT.

(EXAMPLE 101 - 340 VP# 342 - 581)
341

35	10A	2.0,225.0	2,101	2,465	F. Stk	12	
36	10A	2.0,229.0	2,101	2,469	F. Stk	12	
37	10A	2.0,233.0	2,101	2,473	F. Stk	12	
38	10A	2.0,237.0	2,101	2,477	F. Stk	12	
39	10A	2.0,241.0	2,101	2,481	Stk	12	
40	10A	2.0,245.0	2,101	2,485	[illegible]	12	
41	10A	2.0,249.0	2,101	2,489	F. Stk	12	END OF REEL #10 (2 X EOF)
42	11A	2.0,253.0	2,101	2,493	F. Stk	12	START OF REEL # 11.
43	11A	2.0,257.0	2,101	2,497	F. Stk	12	
44	11A	2.0,261.0	2,101	2,501	F. Stk	12	
45	11A	2.0,265.0	2,101	2,505	F. Stk	12	
46	11A	2.0,269.0	2,101	2,509	F. Stk	12	
47	11A	2.0,273.0	2,101	2,513	F. Stk	12	
48	11A	2.0,277.0	2,101	2,517	F. Stk	12	
49	11A	2 0,281.0	2,101	2,521	F. Stk	12	
50	11A	2.0,285.0	2,101	2,525	F. Stk	12	END OF REEL #11 (2 X EOF)
51	12A	2.0,101.0	2,101	2,101	raw	1	Transformer Test At Sta #101 On Blaster Sn#108314. START OF REEL #12.
52	12A	2.0,101.0	2,101	2,101	raw	1	Transformer test at sta #101 bBaster HT600 sn#M-1
53	12A	2.0,101.0	2,101	2,581	raw	1	20 SECOND NOISE STRIP

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54	12A	2.0,101.0	2,101	2,581	raw	1	Shothole #1, uphole time 41.0 ms, 200 lbs @ 111 ft top, 200 ft bottom

NOTE: The line uphole is plugged into sta #102.

55	12A	2.0,178.0	2,101	2,581	raw	1	VOID FILE
56	12A	2.0,178.0	2,101	2,581	raw	1	Shothole #3, uphole time 37.0 ms, 200 lbs @ 111 ft top, 200 ft bottom

NOTE: The line uphole is plugged into sta #179. This shot is offset 70 ft foward of the flag 178.
NOTE: END OF REEL #12 (2 X EOF)

57	13A	2.0,258.0	2,101	2,581	raw	1	START OF NEW REEL #13.
58	13A	2.0,258.0	2,101	2,581	raw	1	VOID FILE
59	13A	2.0,258.0	2,101	2,581	raw	1	VOID FILE
60	13A	2.0,258.0	2,101	2,581	raw	1	Shothole #5, uphole time 31.0 ms, 200 lbs @ 111 ft top, 200 ft bottom

NOTE: OFFSET 30 ft FOWARD OF FLAG 258 30 ft SOUTH.

61	13A	2.0,338.0	2,101	2,581	raw	1	VOID FILE
62	13A	2.0,338.0	2,101	2,581	raw	1	Shothole #7, uphole time 26.0 ms, 200 lbs @ 111 ft top, 200 ft bottom.

NOTE: Offset 10 ft foward of the flag 15 ft south. The line uphole plugged into sta #337.
NOTE: FFID 62 IS END OF REEL #13 (2 X EOF)

63	14A	2.0,289.0	2,101	2,529	F. Stk	12	START OF NEW REEL #14
64	14A	2.0,293.0	2,101	2,533	F. Stk	12	
65	14A	2.0,297.0	2,101	2,537	F. Stk	12	
66	14A	2.0,301.0	2,101	2,541	F. Stk	12	
67	14A	2.0,305.0	2,101	2,545	F. Stk	12	
68	14A	2.0,309.0	2,101	2,549	F. Stk	12	
69	14A	2.0,313.0	2,101	2,553	F. Stk	12	
70	14A	2.0,317.0	2,101	2,557	F. Stk	12	END OF REEL #14 (2 X EOF)

I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
71	15A	2.0,321.0	2,101	2,561	F. Stk	12	START OF NEW REEL #15
72	15A	2.0,325.0	2,101	2,565	F. Stk	12	
73	15A	2.0,329.0	2,101	2,569	F. Stk	12	
74	15A	2.0,333.0	2,101	2,573	F. Stk	12	
75	15A	2.0,337.0	2,101	2,577	F. Stk	12	
76	15A	2.0,341.0	2,101	2,581	F. Stk	12	FIRST FULL SPLIT, END OF REEL #15 (2 X EOF)

NOTE: FFID 76 IS THE LAST VP OF THE DAY 10/28/94.

NOTE: FFID 77 IS START OF NEW DAY 10/29/94.

77	16A	2.0,345.0	2,105	2,585	raw	1	NOISE STRIP, START OF REEL # 16
78	16A	2.0,345.0	2,105	2,585	F. Stk	12	FIRST V/P OF THE DAY
79	16A	2.0,349.0	2,109	2,589	F. Stk	12	Stacked centered on the pinflag for rough terrain
80	16A	2.0,353.0	2,113	2,593	F. Stk	12	
81	16A	2.0,357.0	2,117	2,597	F. Stk	12	
82	16A	2.0,361.0	2,121	2,601	F. Stk	12	
83	16A	2.0,365.0	2,125	2,605	F. Stk	12	
84	16A	2.0,369.0	2,129	2,609	F. Stk	12	
85	16A	2.0,373.0	2,133	2,613	F. Stk	12	END OF REEL # 16 (2 X EOF)

NOTE: DAILY TEST FILES 9015-9128 ARE ON REEL # 8.

86	17A	2.0,377.0	2,137	2,617	F. Stk	12	START OF NEW REEL # 17.
87	17A	2.0,381.0	2,141	2,621	F. Stk	12	
88	17A	2.0,385.0	2,145	2,625	F. Stk	12	
89	17A	2.0,389.0	2,149	2,629	F. Stk	12	
90	17A	2.0,393.0	2,153	2,633	F. Stk	12	
91	17A	2.0,397.0	2,157	2,637	F. Stk	12	

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92	17A	2.0,401.0	2,161	2,641	F. Stk	12	
93	17A	2.0,405.0	2,165	2,645	F. Stk	12	
94	18A	2.0,409.0	2,169	2,649	F. Stk	12	END OF REEL:18 (2 X EOF)

I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
95	19A	2.0,410.0	2,412	2,412	raw	1	VOID FILE, START OF REEL #19
96	19A	2.0,410.0	2,412	2,412	raw	1	TRANSFORMER TEST AT STA #412
97	19A	2.0,410.0	2,170	2,650	raw	1	NOISE STRIP
98	19A	2.0,410.0	2,170	2,650	raw	1	Shothole #9, uphole time 22.0 ms, 200 lbs @ 111 ft top , 200 ft bottom

Hole #09 offset 25 ft from the flag 410 towards flag 411. Line uphole plugged into sta #410.

99	19A	2.0,490.0	2,250	2,730	raw	1	Shothole #11, uphole time 32.0 ms, 200 lbs @ 111 ft top, 200 ft bottom

NOTE: ffid 99 is hole #11 offset 20 ft towards the high numbers of flag #490. The line up hole plugged into sta #490.
NOTE: END OF REEL #19 (2 X EOF)

100	20A	2.0,413.0	2,173	2,653	F. Stk	12	START OF NEW REEL # 20
101	20A	2.0,417.0	2,177	2,657	F. Stk	12	
102	20A	2.0,421.0	2,181	2,661	F. Stk	12	
103	20A	2.0,425.0	2,185	2,665	F. Stk	12	
104	20A	2.0,429.0	2,189	2,669	F. Stk	12	
105	20A	2.0,433.0	2,193	2,673	F. Stk	12	
106	20A	2.0,437.0	2,197	2,677	F. Stk	12	
107	20A	2.0,441.0	2,201	2,681	F. Stk	12	END OF REEL # 20 (2 X EOF)

108	21A	2.0,445.0	2,205	2,685	F. Stk	12	START OF NEW REEL # 21
109	21A	2.0,449.0	2,209	2,689	F. Stk	12	
110	21A	2.0,453.0	2,213	2,693	F. Stk	12	STA #694 HAS REVERSED POLARITY
111	21A	2.0,457.0	2,217	2,697	F. Stk	12	
112	21A	2.0,461.0	2,221	2,701	F. Stk	12	
113	21A	2.0,465.0	2,225	2,705	F. Stk	12	
114	21A	2.0,469.0	2,229	2,709	F. Stk	12	
115	21A	2.0,473.0	2,233	2,713	F. Stk	12	END OF REEL # 21 (2 X EOF)

116	22A	2.0,477.0	2,237	2,717	F. Stk	12	START OF REEL # 22
117	22A	2.0,481.0	2,241	2,721	F Stk	12	
118	22A	2.0,485.0	2,245	2,725	F. Stk	12	
119	22A	2.0,489.0	2,249	2,729	F. Stk	12	
120	22A	2.0,493.0	2,253	2,733	F. Stk	12	
121	22A	2.0,497.0	2,257	2,737	F. Stk	12	
122	22A	2.0,501.0	2,261	2,741	F. Stk	12	
123	22A	2.0,505.0	2,265	2,745	F. Stk	12	END OF REEL # 22 (2 X EOF)

NOTE. FFID 123 IS THE LAST VP OF THE DAY 10/29/94.

NOTE. START OF NEW DAY 10/30/94.
NOTE. DAILY TEST FILES 9015-9128 ARE ON REEL # 8.
NOTE. THERE WILL BE NO MORE DAILY TESTS ON REEL # 8.

124	23A	2.0,509.0	2,269	2,749	raw	1	START OF REEL #23, VOID FILE
125	23A	2.0,509.0	2,269	2,749	raw	1	NOISE STRIP
126	23A	2.0,509.0	2,269	2,749	F Stk	12	FIRST VP OF THE DAY
127	23A	2.0,513.0	2,273	2,753	F St C	12	VOID FILE
128	23A	2.0,513.0	2,273	2,753	F. Stk	12	
129	23A	2.0,517.0	2,277	2,757	F. Stk	12	
130	23A	2.0,521.0	2,281	2,761	F. Stk	12	
131	23A	2.0,525.0	2,285	2,765	F. Stk	12	
132	23A	2.0,529.0	2,289	2,769	F. Stk	12	
133	23A	2.0,533.0	2,293	2,773	F. Stk	12	END OF REEL # 23 (2 X EOF)

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134	24A	2.0.537.0	2.297	2.777	F. Stk	12	START OF REEL # 24
135	24A	2.0.541.0	2.301	2.781	F. Stk	12	
136	24A	2.0.545 0	2.305	2.785	F. Stk	12	
137	24A	2.0.549.0	2.309	2.789	F. Stk	12	
138	24A	2.0.553.0	2.313	2.793	F. Stk	12	
139	24A	2.0.557.0	2.317	2.797	F. Stk	12	
140	24A	2.0.561.0	2.321	2.801	F. Stk	12	
141	24A	2.0.565.0	2.325	2.805	F. Stk	12	END OF REEL #24 (2 X EOF)

I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
142	25A	2.0.569.0	2.329	2.809	F. Stk	12	START OF REEL #25
143	25A	2.0.573.0	2.333	2.813	F. Stk	12	
144	25A	2.0.573.0	2.333	2.813	raw	1	NOISE STRIP
145	25A	2.0.577.0	2.337	2.817	F. Stk	12	
146	25A	2.0.581.0	2.341	2.821	F. Stk	12	
147	25A	2.0.585.0	2.345	2.825	F. Stk	12	
148	25A	2.0.589.0	2.349	2.829	F. Stk	12	
149	24A	2.0.593.0	2.353	2.833	raw	1	NOISE STRIP
150	25A	2.0.593.0	2.353	2.833	F. Stk	12	END OF REEL # 25 (2 X EOF)
151	26A	2.0.597.0	2.357	2.837	F. Stk	12	START OF REEL # 26
152	26A	2.0.601.0	2.361	2.841	F. Stk	12	
153	26A	2.0.605.0	2.365	2.845	F. Stk	12	
154	26A	2.0.609.0	2.369	2.849	F. Stk	12	
155	26A	2.0.613.0	2.373	2.853	F. Stk	12	
156	26A	2.0.617.0	2.377	2.857	F. Stk	12	
157	26A	2.0.621.0	2.381	2.861	F. Stk	12	
158	26A	2.0.625.0	2.385	2.865	F. Stk	12	END OF REEL # 26 (2 X EOF)
159	27A	2.0.629.0	2.389	2.869	F. Stk	12	START OF NEW REEL # 27
160	27A	2.0.633.0	2.393	2.873	F. Stk	12	
161	27A	2.0.637.0	2.397	2.877	raw	1	NOISE STRIP
162	27A	2.0.637.0	2.397	2.877	F. Stk	12	
163	27A	2.0.641.0	2.401	2.881	F. Stk	12	
164	27A	2.0.645.0	2.405	2.885	F. Stk	12	
165	27A	2.0.649.0	2.409	2.889	F. Stk	12	END OF REEL #27 (2 X EOF)

*******NOTE: THE SYSTEM RESET THE FFID TO 161. THESE FFID NUMBERS WILL BE IN SEQUENCE FROM HERE FORWARD.

161	28A	2.0.573.0	2.575	2.575	raw	1	Transformer test at sta #575. START OF REEL #28
162	28A	2.0.573 0	2.333	2.813	raw	1	NOISE STRIP
163	28A	2.0.573.0	2.333	2.813	raw	1	Shothole #13. uphole time 41.0 ms. 200 lbs @ 111 ft top. 200 ft bottom.

NOTE: This is hole #13 50 ft from flag #573 towards flag 574. The line up hole is plugged into flag #573.
NOTE. This is the last shot until the wind calms down.
NOTE: END OF REEL #28 (2 X EOF)

I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	
164	29A	2.0.653.0	2.413	2.893	F. Stk	12	START OF REEL #29
165	29A	2.0.657.0	2.417	2.897	F. Stk	12	
166	29A	2.0.661.0	2.421	2.901	F. Stk	12	
167	29A	2.0.665.0	2.425	2.905	F. Stk	12	END OF REEL #29 (2 X EOF)
168	30A	2.0.653.0	2.655	2.655	raw	1	START OF REEL #30. VOID FILE

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169	30A	2.0,653.0	2,655	2,655	raw	1	VOID FILE
170	30A	2.0,653.0	2,655	2,655	raw	1	TRANSFORMER TEST AT STA #655
171	30A	2.0,653.0	2,413	2,893	raw	1	Shothole 201, uphole time 27.0 ms, 200 lbs @ 111 ft top, 200 ft bottom.

Note: this is hole.#201 line uphole at station 653. This shot is offset 20 ft from flag 653 towards flag 654 40 ft north.

172	30A	2.0,733.0	2,460	2,940	raw	1	NOISE STRIP
173	30A	2.0,733.0	2,460	2,940	raw	1	VOID FILE
174	30A	2.0,733.0	2,460	2,940	raw	1	VOID FILE
175	30A	2.0,733.0	2,460	2,940	raw	1	VOID FILE
176	30A	2.0,733.0	2,460	2,940	raw	1	Shothole 203, uphole time 34.0 ms, 200 lbs @ 111 ft top, 200 ft bottom, END OF REEL #30 (2 X EOF)

Note: this is hole #203 line uphole at station 733. This is offset 50 ftfrom flag 733 towards flag 734.
NOTE: FFID 176 IS THE LAST SHOT OF THE DAY 10/30/94.

NOTE: DAILY INSTRUMENT TEST FILES 9015 - 9128 ARE ON REEL #31A.

I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	
177	32A	2.0,669.0	2,429	2,909	raw	1	START OF NEW DAY 10/31/94 and REEL #32
178	32A	2.0,669.0	2,429	2,909	F. Stk	12	FIRST VIBE OF THE DAY
179	32A	2.0,673.0	2,433	2,913	F. Stk	12	
180	32A	2.0,677.0	2,437	2,917	F. Stk	12	
181	32A	2.0,681.0	2,441	2,921	F. Stk	12	
182	32A	2.0,685.0	2,445	2,925	F. Stk	12	
183	32A	2.0,689.0	2,449	2,929	F. Stk	12	
184	32A	2.0,693.0	2,453	2,933	F. Stk	12	
185	32A	2.0,697.0	2,457	2,937	F. Stk	12	NOISE STRIP, END OF REEL #32 (2 X EOF)
186	33A	2.0,701.0	2,461	2,941	F. Stk	12	START OF REEL #33
187	33A	2.0,705.0	2,465	2,945	F. Stk	12	
188	33A	2.0,709.0	2,469	2,949	F. Stk	12	
189	33A	2.0,713.0	2,473	2,953	F. Stk	12	
190	33A	2.0,717.0	2,477	2,957	F. Stk	12	
191	33A	2.0,721.0	2,481	2,961	F. Stk	12	
192	33A	2.0,725.0	2,485	2,965	F. Stk	12	
193	33A	2.0,729.0	2,489	2,969	F. Stk	12	END OF REEL #33 (2 X EOF)
194	34A	2.0,733.0	2,493	2,973	F. Stk	12	START OF REEL # 34
195	34A	2.0,737.0	2,497	2,977	F. Stk	12	
196	34A	2.0,741.0	2,501	2,981	F Stk	12	
197	34A	2.0,745.0	2,505	2,985	F. Stk	12	
198	34A	2.0,749.0	2,509	2,989	F. Stk	12	
199	34A	2.0,753.0	2,513	2,993	F. Stk	12	
200	34A	2.0,757.0	2,517	2,997	F. Stk	12	END OF REEL # 34 (2 X EOF)
201	35A	2.0,757.0	2,517	2,997	F St C	12	TEST #1. START OF REEL #35

Test #1: 4 vibes over 195 ft pattern centered over the flag 7.5 ft move-up's. 10-50 hz, 12 second sweeps, 12 sweeps (production parameters).

202	35A	2.0,757.0	2,517	2,997	F St C	12	TEST #2

Test #2 4 vibes over 165 ft pattern centered over the flag 4 ft move-up's with a total move-up 44 ft 10-50 hz, 12 second sweeps, 12 sweeps (production parameters).

203	35A	2.0,757.0	2,517	2,997	F St C	12	TEST #3

Test #3. 4 vibes over 165 ft pattern centered over the flag 7.5 ft move-up's with a total move 82.5 ft. 10-50 hz, 12 second sweeps, 12 sweeps (production parameters).

204	35A	2.0,757.0	2,517	2,997	F St C	12	TEST #4

Test #4 4 vibes over 165 ft pattern centered over the flag 7.5 ft move-up's with a total move 82.5 ft. 12hz to 70hz 12 sweeps 12 seconds 8 sec listen.

205	35A	2.0,757.0	2,517	2,997	F St C	12	Test #5, END OF REEL #35 (2 X EOF)

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Test #5 4 vibes over 165 ft pattern centered over the flag 7.5 ft move-up's with a total move 82.5 ft. 12hz to 120hz 12 sweeps 12 seconds 8 sec listen.

NOTE: DAILY INSTRUMENT TEST FILES 9015 - 9128 ARE ON REEL #36A.

NOTE: START OF NEW DAY 11/1/94.

206	37A	2.0,761.0	2,521	2,1002	raw	1	START OF REEL #37, NOISE STRIP
207	37A	2.0,761.0	2,521	2,1002	F. Stk	12	FIRST VP OF THE DAY, STA #994 IS OPEN
208	37A	2.0,765.0	2,525	2,1006	F. Stk	12	
209	37A	2.0,769.0	2,529	2,1010	F. Stk	12	
210	37A	2.0,773.0	2,533	2,1014	F. Stk	12	
211	37A	2.0,777.0	2,537	2,1018	F. Stk	12	STA #994 IS FIXED
212	37A	2.0,781.0	2,541	2,1022	F. Stk	12	
213	37A	2.0,785.0	2,545	2,1026	F. Stk	12	END OF REEL #37 (2 X EOF)
214	38A	2.0,789.0	2,549	2,1030	F. Stk	12	START OF REEL #38
215	38A	2.0,793.0	2,553	2,1034	F. Stk	12	
216	38A	2.0,797.0	2,557	2,1038	F. Stk	12	
217	38A	2.0,801.0	2,561	2,1042	F. Stk	12	
218	38A	2.0,805.0	2,565	2,1046	F. Stk	12	
219	38A	2.0,809.0	2,569	2,1050	F. Stk	12	
220	38A	2.0,811.0	2,571	2,1051	F. Stk	12	VOID FILE
221	38A	2.0,813.0	2,573	2,1054	F. Stk	12	VOID FILE, END OF REEL #38 (2 X EOF)

I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	
222	39A	2.0,817.0	2,577	2,1058	F. Stk	12	VOID FILE, START OF REEL #39
223	39A	2.0,813.0	2,813	2,813	raw	1	TRANSFORMER TEST AT STA #813
224	39A	2.0,811.0	2,571	2,1051	raw	1	NOISE STRIP
225	39A	2.0,811.0	2,571	2,1051	raw	1	Shothole #205, uphole time 30.0 ms, 200 lbs @ 111 ft top, 200 ft bottom.

Note: The line uphole is plugged into sta #811. Offset 15 ftback from flag 811 towards flag 810.

226	39A	2.0,811.0	2,571	2,1051	raw	1	Shothole #205a, uphole time 37.0 ms, 200 lbs @ 111 ft top,200 ft bottom.

Note: The line uphole is plugged into sta #813. Offset between flag 813 & 814.

227	39A	2.0,811.0	2,571	2,1051	raw	1	Shothole #205b, uphole time 38.0 ms, 200 lbs @ 111 ft top, 200 ft bottom.

Note: The line uphole is plugged into sta #815. Offset between flag 815 & 816.

NOTE: END OF REEL #39 (2 X EOF)

228	40A	2.0,813.0	2,573	2,1054	F St C	12	VOID FILE, START OF REEL # 40
229	40A	2.0,813.0	2,573	2,1054	F. Stk	12	
230	40A	2.0,817.0	2,577	2,1058	F. Stk	12	
231	40A	2.0,821.0	2,581	2,1062	F. Stk	12	
232	40A	2.0,825.0	2,585	2,1066	F. Stk	12	
233	40A	2.0,829.0	2,589	2,1070	F. Stk	12	
234	40A	2.0,833.0	2,593	2,1074	F. Stk	12	
235	40A	2.0,837.0	2,597	2,1078	F. Stk	12	END OF REEL # 40 (2 X EOF)

NOTE: THIS IS THE LAST VP OF THE DAY 11/1/94.

NOTE: START OF NEW DAY 11/2/94.

NOTE: Daily test files 9015 - 9128 there is 2 set's of daily test for 2 different part's of line so we could test all 600 channels all on reel #36.

******NOTE: THE SYSTEM RESET FILE BACK TO FILE #223 WE DID NOT CATCH THIS SO FROMTHIS POINT FORWARD THE FILES ARE IN SEQUENCE. "OB ERROR"

I/O SYSTEM TWO OBSERVER report summary

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File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
223	41A	2,0,841.0	2,601	2,1082	raw	1	NOISE STRIP, START OF NEW REEL #41
224	41A	2,0,841.0	2,601	2,1082	F. Stk	12	FIRST VP OF THE DAY
225	41A	2,0,845.0	2,605	2,1086	F. Stk	12	STA #794 WENT OPEN
226	41A	2,0,849.0	2,609	2,1090	F. Stk	12	
227	41A	2,0,853.0	2,613	2,1094	F. Stk	12	
228	41A	2,0,857.0	2,617	2,1098	F. St C	12	VOID FILE, STA # 794 FIXED NOW
229	41A	2,0,857.0	2,617	2,1098	F. Stk	12	
230	41A	2,0,861.0	2,621	2,1102	F. Stk	12	
231	41A	2,0,865.0	2,625	2,1106	F. Stk	12	END OF REEL #41 (2 X EOF)
232	42A	2,0,869.0	2,629	2,1110	F. Stk	12	START OF REEL #42
233	42A	2,0,873.0	2,633	2,1114	F. Stk	12	
234	42A	2,0,877.0	2,637	2,1118	F. Stk	12	
235	42A	2,0,881.0	2,641	2,1122	F. Stk	12	
236	42A	2,0,885.0	2,645	2,1126	F. Stk	12	
237	42A	2,0,889.0	2,649	2,1130	F. Stk	12	LAST FULL SPLIT
238	42A	2,0,893.0	2,653	2,1133	F. Stk	12	
239	42A	2,0,897.0	2,657	2,1133	F. Stk	12	END OF REEL #42 (2 X EOF)
240	43A	2,0,901.0	2,661	2,1133	F. Stk	12	START OF REEL #43
241	43A	2,0,905.0	2,665	2,1133	F. Stk	12	
242	43A	2,0,909.0	2,669	2,1133	F. Stk	12	
243	43A	2,0,913.0	2,673	2,1133	F. Stk	12	
244	43A	2,0,917.0	2,677	2,1133	F. Stk	12	
245	43A	2,0,921.0	2,681	2,1133	F. Stk	12	
246	43A	2,0,925.0	2,685	2,1133	F. Stk	12	
247	43A	2,0,929.0	2,689	2,1133	F. Stk	12	END OF REEL #43 (2 X EOF)
248	44A	2,0,933.0	2,693	2,1133	F. Stk	12	START OF REE' '44
249	44A	2,0,937.0	2,697	2,1133	F. Stk	12	
250	44A	2,0,941.0	2,701	2,1133	F. Stk	12	
251	44A	2,0,945.0	2,705	2,1133	F. Stk	12	END OF REEL #44
252	45A	2,0,895.0	2,893	2,893	raw	1	Transformer test at sta #893, START OF REEL #45
253	45A	2,0,895.0	2,652	2,1133	raw	1	NOISE STRIP
254	45A	2,0,895.0	2,652	2,1133	raw	1	Shothole #207, uphole time 33.0 ms, 200 lbs @ 111 ft top, 200 ft bottom.

Note: the line uphole is plugged into sta #895. This shot is offset 20 ft north.

255	45A	2,0,941.0	2,701	2,1133	raw	1	

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NOTE: THERE WAS A MISFIRE 40 LBS AND ONE CAP WASTED. THIS MISFIRE WAS NOT RECORDED.

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256	45A	2,0,945.0	2,705	2,1133	raw	1	STA # 1133 IS OPEN
257	45A	2,0,947.0	2,707	2,1133	raw	1	
258	45A	2,0,949.0	2,709	2,1133	raw	1	
259	45A	2,0,951.0	2,711	2,1133	raw	1	
260	45A	2,0,953.0	2,713	2,1133	raw	1	
261	45A	2,0,955.0	2,715	2,1133	raw	1	
262	45A	2,0,957.0	2,717	2,1133	raw	1	
263	45A	2,0,959.0	2,719	2,1133	raw	1	
264	45A	2,0,961.0	2,721	2,1133	raw	1	STA # 1133 FIXED
265	45A	2,0,963.0	2,723	2,1133	raw	1	
266	45A	2,0,965.0	2,725	2,1133	raw	1	
267	45A	2,0,967.0	2,727	2,1133	raw	1	
268	45A	2,0,969.0	2,729	2,1133	raw	1	
269	45A	2,0,971.0	2,731	2,1133	raw	1	
270	45A	2,0,973.0	2,733	2,1133	raw	1	VOID FILE
271	45A	2,0,973.0	2,733	2,1133	raw	1	END OF REEL #45 (2 X EOF)

NOTE: FFID 255-271 ARE POULTER SHOTS 40 LBS OVER 82.5 ft.

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272	46A	2.0,975.0	2.735	2.1133	raw	1	START OF REEL #46

NOTE: FFID 272 IS A POULTER SHOT 40 LBS OVER 82.5 ft.

273	46A	2.0,980.0	2.652	2.1133	raw	1	NOISE STRIP
274	46A	2.0,980.0	2.652	2.1133	raw	1	Shothole #208.5a, uphole time 19.0 ms, 100 lbs @ 56 ft top, 100 ft bottom.

Note: the line uphole is plugged into sta #980. This shot is offset between the flag #979 & 980.

275	46A	2.0,980.0	2.652	2.1133	raw	1	Shothole #208.5b, uphole time 17.0 ms, 100 lbs @ 56 ft top, 100 ft bottom.

Note: the line uphole is plugged into sta #980. This shot is offset between flags #980 & 981.

NOTE: END OF REEL #46. LAST SHOT OF THE DAY, 11/02/94.

NOTE: START OF NEW DAY 11/3/94.

I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
276	47A	2.0,979.0	2.979	2.979	raw	1	Transformer test @ sta #979, START OF REEL # 47
277	47A	2.0,977.0	2.737	2.1133	raw	1	NOISE STRIP
278	47A	2.0,977.0	2.737	2.1133	raw	1	FIRST POULTER SHOT OF THE DAY
279	47A	2.0,979.0	2.739	2.1133	raw	1	
280	47A	2.0,981.0	2.741	2.1133	raw	1	
281	47A	2.0,983.0	2.743	2.1133	raw	1	
282	47A	2.0,985.0	2.745	2.1133	raw	1	VOID FILE
283	47A	2.0,985.0	2.745	2.1133	raw	1	
284	47A	2.0,987.0	2.747	2.1133	raw	1	
285	47A	2.0,989.0	2.749	2.1133	raw	1	
286	47A	2.0,991.0	2.751	2.1133	raw	1	
287	47A	2.0,993.0	2.753	2.1133	raw	1	
288	47A	2.0,995.0	2.755	2.1133	raw	1	
289	47A	2.0,997.0	2.757	2.1133	raw	1	
290	47A	2.0,998.0	2.758	2.1133	raw	1	
291	47A	2.0,1001.0	2.761	2.1133	raw	1	
292	47A	2.0,1003.0	2.763	2.1133	raw	1	
293	47A	2.0,1005.0	2.765	2.1133	raw	1	
294	47A	2.0,1007.0	2.767	2.1133	raw	1	
295	47A	2.0,1009.0	2.769	2.1133	raw	1	
296	47A	2.0,1011.0	2.771	2.1133	raw	1	
297	47A	2.0,1013.0	2.773	2.1133	raw	1	
298	47A	2.0,1015.0	2.775	2.1133	raw	1	
299	47A	2.0,1017.0	2.777	2.1133	raw	1	END OF REEL #47 (2 X EOF)

NOTE: FFID 278-299 ARE POULTER SHOTS 40 LBS OVER 82.5 ft.

NOTE:DAILY TEST 9015 - 9128 ON REEL #36

I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
300	48A	2.0,1019.0	2.779	2.1133	raw	1	START OF REEL #48
301	48A	2.0,1021.0	2.781	2.1133	raw	1	
302	48A	2.0,1023.0	2.783	2.1133	raw	1	
303	48A	2.0,1025.0	2.785	2.1133	raw	1	
304	48A	2.0,1027.0	2.787	2.1133	raw	1	
305	48A	2.0,1029.0	2.789	2.1133	raw	1	
306	48A	2.0,1072.0	2.832	2.1133	raw	1	NOISE STRIP

NOTE: FFID 300-305 ARE POULTER SHOTS 40 LBS OVER 82.5 ft.

307	48A	2.0,1072.0	2.652	2.1133	raw	1	Shothole #211b, uphole time 24.0 ms, 100 lbs @ 56 ft top, 100 ft bottom.

Note: the line uphole is plugged into sta #1072. Offset parallel to sta #1072.

308	48A	2.0,1072.0	2.652	2.1133	raw	1	Shothole #211a, uphole time 20.0 ms, 100 lbs @ 56 ft top, 100 ft bottom.

Note: the line uphole is plugged into sta #1072. Offset between flags 1072 & 1073.

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309	48A	2.0,1030.0	2,790	2,1133	raw	1	
310	48A	2.0,1033.0	2,793	2,1133	raw	1	
311	48A	2.0,1035.0	2,795	2,1133	raw	1	
312	48A	2.0,103[illegible].0	2,797	2,1133	raw	1	
313	48A	2.0,1039.0	2,799	2,1133	raw	1	
314	48A	2.0,1041.0	2,801	2,1133	raw	1	
315	48A	2.0,1043.0	2,803	2,1133	raw	1	
316	48A	2.0,1045.0	2,805	2,1133	raw	1	
317	48A	2.0,1047.0	2,807	2,1133	raw	1	
318	48A	2.0,1049.0	2,809	2,1133	raw	1	35 LB SHOT OVER 82.5 ft
319	48A	2.0,1051.0	2,811	2,1133	raw	1	50 LB SHOT OVER 82.5 ft
320	48A	2.0,1053.0	2,813	2,1133	raw	1	END OF REEL #48 (2 X EOF)

NOTE: FFID 309-320 ARE POULTER SHOTS 40 LBS OVER 82.5 ft.

I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
321	49A	2.0,1055.0	2,815	2,1133	raw	1	START OF REEL # 49
322	49A	2.0,1057.0	2,817	2,1133	raw	1	
323	49A	2.0,1059.0	2,819	2,1133	raw	1	
324	49A	2.0,1061.0	2,821	2,1133	raw	1	
325	49A	2.0,1063.0	2,823	2,1133	raw	1	
326	49A	2.0,1065.0	2,825	2,1133	raw	1	
327	49A	2.0,1067.0	2,827	2,1133	raw	1	
328	49A	2.0,1069.0	2,829	2,1133	raw	1	
329	49A	2.0,1071.0	2,831	2,1133	raw	1	
330	49A	2.0,1073.0	2,833	2,1133	raw	1	
331	49A	2.0,1075.0	2,835	2,1133	raw	1	
332	49A	2.0,1077.0	2,837	2,1133	raw	1	
333	49A	2.0,1079.0	2,839	2,1133	raw	1	
334	49A	2.0,1081.0	2,841	2,1133	raw	1	
335	49A	2.0,1083.0	2,843	2,1133	raw	1	LAST SHOT OF THE DAY

NOTE: FFID 321-335 ARE POULTER SHOTS 40 LBS OVER 82.5 ft.

NOTE: DAILY INSTRUMENT TEST FILES 9015 - 9128 ARE ON REEL #50A.

NOTE: START OF NEW DAY 11/4/94. 3

I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	
336	51A	2.0,979.0	2,1086	2,1086	raw	1	VOID FILE. START OF REEL #51
337	51A	2.0,979.0	2,1086	2,1086	raw	1	TRANSFORMER TEST
338	51A	2.0,1085.0	2,845	2,1133	raw	1	NOISE STRIP
339	51A	2.0,1085.0	2,845	2,1133	raw	1	
340	51A	2.0,1087.0	2,847	2,1133	raw	1	
341	51A	2.0,1089.0	2,849	2,1133	raw	1	
342	51A	2.0,1091.0	2,851	2,1133	raw	1	
343	51A	2.0,1093.0	2,853	2,1133	raw	1	
344	51A	2.0,1095.0	2,855	2,1133	raw	1	
345	51A	2.0,1097.0	2,857	2,1133	raw	1	
346	51A	2.0,1099.0	2,859	2,1133	raw	1	
347	51A	2.0,1101.0	2,861	2,1133	raw	1	
348	51A	2.0,1103.0	2,863	2,1133	raw	1	
349	51A	2.0,1105.0	2,865	2,1133	raw	1	VOID FILE
350	51A	2.0,1105.0	2,865	2,1133	raw	1	
351	51A	2.0,1107.0	2,867	2,1133	raw	1	
352	51A	2.0,1109.0	2,869	2,1133	raw	1	
353	51A	2.0,1111.0	2,871	2,1133	raw	1	
354	51A	2.0,1113.0	2,873	2,1133	raw	1	
355	51A	2.0,1115.0	2,875	2,1133	raw	1	
356	51A	2.0,1117.0	2,877	2,1133	raw	1	

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357	51A	2.0,1119.0	2,879	2,1133	raw	1	
358	51A	2.0,1121.0	2,881	2,1133	raw	1	
359	51A	2.0,1123.0	2,883	2,1133	raw	1	
360	51A	2.0,1125.0	2,885	2,1133	raw	1	
361	51A	2.0,1126.0	2,886	2,1133	raw	1	SHOT ON STATION # 1126 FOR A ROAD
362	51A	2.0,1129.0	2,889	2,1133	raw	1	
363	51A	2.0,1131.0	2,891	2,1133	raw	1	
364	51A	2.0,1133.0	2,893	2,1133	raw	1	END OF REEL # 51 (2 X EOF)

NOTE: FFID 339-364 ARE POULTER SHOTS 40 LBS OVER 82.5 ft.
NOTE: FFID 364 IS THE LAST POULTER SHOT ON LINE 2SW-2.

End of OBSERVER data.

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APPENDIX 6. OBSERVERS LOG FOR LINE 3

NORTHERN GEOPHYSICAL OF AMERICA
I/O SYSTEM TWO
CREW #110, LINE 3
YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
CLIENT: U.S. Geological Survey
11/11/94

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GENERAL COMMENTS

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RECORDING PARAMETERS ARE AS FOLLOWS
((I/O SYSTEM TWO))
LOWCUT OUT (DEFAULT FILTER (3.0 HZ @ 12db SLOPE)
HIGHCUT 1/2 NYQUIST MINIMUM PHASE (135 HZ @190 db SLOPE)

((PREAMP GAIN'S ARE AT 48db))

(HPE OUT)

(VIBROSEIS AUX'S)

INPUT Aux 1 PILOT	Tape Aux 1
INPUT Aux 2 PILOT FLD	Tape Aux 2
INPUT Aux 5 CLOCK	Tape Aux 3
INPUT Aux 12 100 hz	Tape Aux 5

(DOWNHOLE EXPLOSIVES AUX'S)

INPUT Aux 5 CLOCK T.B.	Tape Aux 1
INPUT Aux 6 CONFIRMATION T.B.	Tape Aux 2
INPUT Aux 9 ANALOG UPHOLE	Tape Aux 3
INPUT Aux 11 N/A	Tape Aux 4
INPUT Aux 12 100 hz	Tape Aux 5

(MINIHOLE AND POULTER SHOT SURFACE SEIS EXPLOSIVES)

INPUT Aux 5 CLOCK T.B.	Tape Aux 1
INPUT Aux 6 CONFIRMATION T.B.	Tape Aux 2
INPUT Aux 12 100 hz	Tape Aux 3

TAPE FORMAT: SEG-D 4 BYTE..SAMPLE RATE 2ms

NOTE: LINE SHOT FROM B.O.L. (101) TO E.O.L. (541) STARTING WITH 240 CHANNELS LIVE ROLLING INTO A FULL SPLIT OF 220/220 ENDING WITH 240 CHANNELS LIVE.

"SPREAD CONFIGURATION"
24 GEOPHONES PLANTED INLINE OVER 165 ft
GEOPHONES ARE GEOSPACE 20 D'S 10hz
NOTE: VIB'S ARE MERTZ MODEL 18
SYSTEM ARE PELTON ADVANCED 2 5.0
THE SWEEP USEDWAS,
10-50 hz LINEAR 12-12 SEC SWEEPS.
NOTE: WE ALSO USED POULTER SHOT DYNAMITE,
40 LBS OF OF SURFACE-SIZE EXPLOSIVES OVER 82.5 FT

NOTE: WE USED DOWNHOLE EXPLOSIVES,
200 LB. CHARGE AT 200 ft.
100 LB. CHARGE AT 100 ft.

NOTE: WE ALSO SHOT MINIHOLE PATTERNS, 5 HOLES X 2LBS. OVER 82.5 FT.

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NOTE: THE FOLLOWING STATIONS ARE ROADS AND AMBIENT NOISE LOCATIONS.

STA #126
STA #163 - 232, SWITCHBACK ROADS
STA #305 - 346, SWITCHBACK ROADS
STA #362
STA #419 - WATERLINE
STA #451
STA #457
STA #541 - E.O.L. - POWER PLANT

NOTE: THE FOLLOWING STATIONS ARE STACKED FOR ELEVATION CHANGE.

STA # 230 - OVER 145 ft
STA # 231 - OVER 120 ft
STA # 232 - OVER 85 ft
STA # 248 - OVER 145 ft
STA # 249 - OVER 120 ft
STA # 250 - OVER 85 ft
STA # 251 - OVER 85 ft
STA # 252 - OVER 145 ft
STA # 253 & 245 OVER 85 ft
STA # 255 - OVER 85 ft
STA # 256 - OVER 120 ft
STA # 257 - 312 OVER 145 ft
STA # 357, 358, 359, 360 - OVER 85 ft

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I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
1	52A	3.0.101.0	3,101	3,341	raw	1	NOISE STRIP, START OF REEL #52

NOTE: START OF NEW DAY 11/5/94.
NOTE: DAILY TEST FILES 9015 - 9128.

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
2	52A	3.0.101.0	3,101	3,341	F. Stk	12	VOID FILE
3	52A	3.0.101.0	3,101	3,341	F. Stk	12	First vp of the line #3. #214 went open and sta #293 is shorted
4	52A	3.0.103.0	3,101	3,343	F. Stk	12	
5	52A	3.0.105.0	3,101	3,345	F. Stk	12	
6	52A	3.0.107.0	3,101	3,347	F. Stk	12	
7	52A	3.0.109.0	3,101	3,349	F. Stk	12	
8	52A	3.0.111.0	3,101	3,351	F. Stk	12	
9	52A	3.0.113.0	3,101	3,353	F. Stk	12	STA #214 IS FIXED
10	52A	3.0.115.0	3,101	3,355	F. Stk	12	
11	52A	3.0.117.0	3,101	3,357	F. Stk	12	
12	52A	3.0.119.0	3,101	3,359	F. Stk	12	END OF REEL #52 (2 X EOF)
13	53A	3.0.121.0	3,101	3,361	F. Stk	12	START OF REEL #53
14	53A	3.0.123.0	3,101	3,363	F. Stk	12	
15	53A	3.0.125.0	3,101	3,365	F. Stk	12	
16	53A	3.0.127.0	3,101	3,367	F. Stk	12	
17	53A	3.0.129.0	3,101	3,369	F. Stk	12	Last V/P Of 11/5/94, End Of Reel # 53 (2 X EOF)

NOTE: DAILY INSTRUMENT TESTS ARE ON REEL # 54.

NOTE: START OF NEW DAY 11/06/94.
I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments

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18	55A	3.0,127.0	3,127	3,127	raw	1	Transformer test of the M-1 blaster, start of reel # 55.
19	55A	3.0,127.0	3,101	3,367	raw	1	NOISE STRIP
20	55A	3.0,127.0	3,101	3,367	raw	1	NOISE STRIP
21	55A	3.0,127.0	3,101	3,367	raw	1	VOID FILE
22	55A	3.0,127.0	3,101	3,367	raw	1	FIRST POULTER SHOT OF THE DAY
23	55A	3.0,129.0	3,101	3,369	raw	1	
24	55A	3.0,131.0	3,101	3,371	raw	1	
25	55A	3.0,133.0	3,101	3,373	raw	1	
26	55A	3.0,135.0	3,101	3,375	raw	1	
27	55A	3.0,137.0	3,101	3,377	raw	1	
28	55A	3.0,139.0	3,101	3,379	raw	1	
29	55A	3.0,141.0	3,101	3,381	raw	1	
30	55A	3.0,143.0	3,101	3,383	raw	1	
31	55A	3.0,145.0	3,101	3,385	raw	1	
32	55A	3.0,147.0	3,101	3,387	raw	1	
33	55A	3.0,149.0	3,101	3,389	raw	1	
34	55A	3.0,151.0	3,101	3,391	raw	1	
35	55A	3.0,153.0	3,101	3,393	raw	1	
36	55A	3.0,155.0	3,101	3,395	raw	1	
37	55A	3.0,157.0	3,101	3,397	raw	1	
38	55A	3.0,159.0	3,101	3,399	raw	1	
39	55A	3.0,161.0	3,101	3,401	raw	1	
40	55A	3.0,163.0	3,101	3,403	raw	1	
41	55A	3.0,165.0	3,101	3,405	raw	1	Last Poulter Shot, End Of Reel #55 (2 X EOF)

NOTE: FFID 22-41 ARE POULTER SHOTS 40 LBS OVER 82.5 ft.

42	56A	3.0,164.0	3,101	3,404	F. Stk	12	VOID FILE
43	56A	3.0,164.0	3,101	3,404	F. Stk	12	First vibe point of day, start of reel # 56
44	56A	3.0,165.0	3,101	3,405	F. Stk	12	
45	56A	3.0,167.0	3,101	3,407	F. Stk	12	
46	56A	3.0,169.0	3,101	3,409	F. Stk	12	
47	56A	3.0,171.0	3,101	3,411	F. Stk	12	
48	56A	3.0,173.0	3,101	3,413	F. Stk	12	
49	56A	3.0,175.0	3,101	3,415	F. Stk	12	
50	56A	3.0,177.0	3,101	3,417	F. Stk	12	
51	56A	3.0,179.0	3,101	3,419	F. Stk	12	VOID FILE
52	56A	3.0,179.0	3,101	3,419	F. Stk	12	
53	56A	3.0,181.0	3,101	3,421	F. Stk	12	END OF REEL # 56 (2 X EOF)

Note: FFID 47-48, 50 is a 165 ft vibe pattern bumper to bumper with seven ft move-up's every sweep starting at the flag.

I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
54	57A	3.0,183.0	3,101	3,423	F. Stk	12	START OF REEL # 57 .
55	57A	3.0,185.0	3,101	3,425	F St C	12	VP IS CORRELATED AFTER STACK
56	57A	3.0,185.0	3,101	3,425	F. Stk	12	LAST V/P OF THE DAY . 11/06/94
57	57A	3.0,187.0	3,101	3,427	raw	1	NOISE STRIP
59	57A	3.0,187.0	3,101	3,427	raw	1	NOISE STRIP

NOTE: START OF NEW DAY 11/07/94.

60	57A	3.0,187.0	3,101	3,427	F. Stk	12	First V/P Of The Day, Sta # 509 is shorted
61	57A	3.0,189.0	3,101	3,429	F. Stk	12	
62	57A	3.0,191.0	3,101	3,431	F. Stk	12	
63	57A	3.0,193.0	3,101	3,433	F. Stk	12	
64	57A	3.0,195.0	3,101	3,435	F. Stk	12	
65	57A	3.0,197.0	3,101	3,437	F. Stk	12	
66	57A	3.0,199.0	3,101	3,439	raw	1	NOISE STRIP
67	57A	3.0,199.0	3,101	3,439	F. Stk	12	END OF REEL # 57 (2 X EOF)

NOTE. Ffid 67 is a 165 ft vibe pattern bumper to bumper with seven ft move-up's every sweep starting at the flag.

68	58A	3.0,201.0	3,101	3,441	F. Stk	12	START OF NEW REEL # 58.
69	58A	3.0,203.0	3,101	3,443	F. Stk	12	

70	58A	3.0,205.0	3,101	3,445	F. Stk	12	
71	58A	3.0,207.0	3,101	3,447	F. Stk	12	
72	58A	3.0,209.0	3,101	3,449	F. Stk	12	
73	58A	3.0,211.0	3,101	3,451	F. Stk	12	
74	58A	3.0,213.0	3,101	3,453	F. Stk	12	
75	58A	3.0,215.0	3,101	3,455	F. Stk	12	
76	58A	3.0,217.0	3,101	3,457	F. Stk	12	
77	58A	3.0,219.0	3,101	3,459	F. Stk	12	END OF REEL # 58 (2 X EOF)

NOTE: FFID 68-69 are 165 ft vibe patterns bumper to bumper with seven ft move-up's every sweep starting at the flag.

I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
78	59A	3.0,221.0	3,101	3,461	F. Stk	12	START OF REEL # 59
79	59A	3.0,223.0	3,101	3,463	F. Stk	12	
80	59A	3.0,225.0	3,101	3,465	F. Stk	12	
81	59A	3.0,227.0	3,101	3,467	F. Stk	12	
82	59A	3.0,229.0	3,101	3,469	F. Stk	12	
83	59A	3.0,231.0	3,101	3,471	F. Stk	12	
84	59A	3.0,233.0	3,101	3,473	F. Stk	12	
85	59A	3.0,235.0	3,101	3,475	F. Stk	12	

NOTE: FFID 82-83 are 165 ft vibe pattern bumper to bumper with seven ft move-up's every sweep starting at the flag.
NOTE: FFID 85 the vibes will be making a large drive around to v/p # 311.

86	59A	3.0,311.0	3,101	3,541	raw	1	NOISE STRIP
87	59A	3.0,311.0	3,101	3,541	raw	1	NOISE STRIP
88	59A	3.0,311.0	3,101	3,541	F. Stk	12	Sta # 400 is shorted, sta #497 has reversed polarity

NOTE: END OF REEL # 59 (2 X EOF)
NOTE: THIS IS THE FIRST V/P WITH THE ENTIRE LINE LIVE (441 STATIONS)

89	60A	3.0,313.0	3,101	3,541	F. Stk	12	START OF REEL # 60
90	60A	3.0,315.0	3,101	3,541	F. Stk	12	
91	60A	3.0,317.0	3,101	3,541	F. Stk	12	
92	60A	3.0,319.0	3,101	3,541	F. Stk	12	
93	60A	3.0,321.0	3,101	3,541	F. Stk	12	
94	60A	3.0,323.0	3,101	3,541	F. Stk	12	
95	60A	3.0,325.0	3,101	3,541	F. Stk	12	
96	60A	3.0,327.0	3,101	3,541	F. Stk	12	END OF REEL # 60 (2 X EOF)

97	61A	3.0,329.0	3,101	3,541	F. Stk	12	START OF REEL # 61
98	61A	3.0,331.0	3,101	3,541	F. Stk	12	
99	61A	3.0,333.0	3,101	3,541	F. Stk	12	
100	61A	3.0,335.0	3,101	3,541	F. Stk	12	
101	61A	3.0,337.0	3,101	3,541	F. Stk	12	Last v/p of the night, END OF REEL #61 (2 X EOF)

I/O SYSTEM TWO OBSERVER report summary

File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS
102	63A	3.0,418.0	3,418	3,418	raw	1

NOTE: START OF REEL #63..START OF NEW DAY 11/09/94.
NOTE: WE RAN MONTHLY TEST FILES 9015 - 9272 ON REEL #62.
NOTE: FFID 102 IS A TRANSFORMER TEST @ STA #418.

103	63A	3.0,232.0	3,124	3,124	raw	1	VOID FILE
104	63A	3.0,232.0	3,124	3,124	raw	1	VOID FILE
105	63A	3.0,232.0	3,232	3,232	raw	1	Transformer test for the first shooter
106	63A	3.0,232.0	3,101	3,541	raw	1	NOISE STRIP
107	63A	3.0,232.0	3,101	3,541	raw	1	NOISE STRIP
108	63A	3.0,232.0	3,101	3,541	raw	1	Shothole #305a, u.H.Time 12.0 ms, 100 lbs @ 56 ftt.,100 fib.

NOTE: the line uphole is plugged into sta #232 @ the shot is located between flags 232 @ 233.
NOTE: STA #125 WENT OPEN.

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109	63A	3.0,232.0	3,101	3,541	raw	1	Shothole #305b, u.H.Time T2.6 ms,400 lbs @ 56 ft.,100 ftb.

NOTE: The line uphole is plugged into sta #232 @ the shot is located between flags 232 @ 233.

110	63A	3.0,233.0	3,101	3,473	raw	1	POULTER SHOT 40 LBS OVER 82.5 ft

NOTE: STA #125 IS GOOD NOW.

111	63A	3.0,437.0	3,197	3,541	F. Stk	12	
112	63A	3.0,439.0	3,199	3,541	F. Stk	12	
113	63A	3.0,441.0	3,201	3,541	F. Stk	12	
114	63A	3.0,443.0	3,203	3,541	F. Stk	12	
115	63A	3.0,445.0	3,205	3,541	F. Stk	12	
116	63A	3.0,447.0	3,207	3,541	F. Stk	12	
117	63A	3.0,449.0	3,209	3,541	F. Stk	12	END OF REEL #63 (2 X EOF)

NOTE: FFID 111-117. VIB WORK. THESE VPS ARE STACKED TO THE LOW SIDE FOR ROUGH TERRAIN.

118	64A	3.0,451.0	3,211	3,541	F. Stk	12	START OF REEL #64
119	64A	3.0,452.0	3,212	3,541	F. Stk	12	VP 452 IS FOR VP 455
120	64A	3.0,453.0	3,213	3,541	F. Stk	12	
121	64A	3.0,461.0	3,221	3,541	F. Stk	12	
122	64A	3.0,462.0	3,222	3,541	F. Stk	12	V.P #462 IS FOR V.P #457
123	64A	3.0,463.0	3,223	3,541	F. Stk	12	
124	64A	3.0,464.0	3,224	3,541	F. Stk	12	V.P #464 IS FOR V.P #459
125	64A	3.0,465.0	3,225	3,541	F. Stk	12	
126	64A	3.0,467.0	3,227	3,541	F. Stk	12	
127	64A	3.0,469.0	3,229	3,541	F. Stk	12	
128	64A	3.0,471.0	3,231	3,541	F. Stk	12	END OF REEL #64 (2 X E.O.F.)

NOTE: FFID 118, 120-121. THESE VPS ARE STACKED TO THE LOW SIDE FOR ROUGH TERRAIN.

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File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
129	65A	3.0,473.0	3,233	3,541	F. Stk	12	START OF REEL #65
130	65A	3.0,475.0	3,235	3,541	F. Stk	12	
131	65A	3.0,477.0	3,237	3,541	F. Stk	12	
132	65A	3.0,479.0	3,239	3,541	F. Stk	12	
133	65A	3.0,481.0	3,241	3,541	F. Stk	12	
134	65A	3.0,483.0	3,243	3,541	F. Stk	12	
135	65A	3.0,485.0	3,245	3,541	F. Stk	12	
136	65A	3.0,235.0	3,101	3,475	raw	1	
137	65A	3.0,237.0	3,101	3,477	raw	1	MISSFIRE THIS WAS A 30 LB SHOT.
138	65A	3.0,239.0	3,101	3,479	raw	1	WAS A 50 LB SHOT
139	65A	3.0,241.0	3,101	3,481	raw	1	
140	65A	3.0,243.0	3,101	3,483	raw	1	
141	65A	3.0,245.0	3,101	3,485	raw	1	
142	65A	3.0,247.0	3,101	3,487	raw	1	
143	65A	3.0,249.0	3,101	3,489	raw	1	END OF REEL #65 (2 X E.O.F.)

NOTE: FFID 129-135 ARE VPS.

NOTE: FFID 136-143 ARE POULTER SHOTS 40 LBS OVER 82.5 ft.

144	66A	3.0,487.0	3,247	3,541	F. Stk	12	START OF VIB'S AGAIN, START OF REEL #66
145	66A	3.0,489.0	3,249	3,541	F. Stk	12	VP IS OFFSET 50 ft TO THE SOUTH
146	66A	3.0,491.0	3,251	3,541	F. Stk	12	VP IS OFFSET 100 ft TO THE SOUTH
147	66A	3.0,493.0	3,253	3,541	F. Stk	12	
148	66A	3.0,495.0	3,255	3,541	F. Stk	12	
149	66A	3.0,497.0	3,257	3,541	F. Stk	12	
150	66A	3.0,499.0	3,259	3,541	F. Stk	12	
151	66A	3.0,501.0	3,261	3,541	F. Stk	12	
152	66A	3.0,503.0	3,263	3,541	F. Stk	12	
153	66A	3.0,505.0	3,265	3,541	F. Stk	12	
154	66A	3.0,507.0	3,267	3,541	F. Stk	12	
155	66A	3.0,509.0	3,269	3,541	F. Stk	12	END OF REEL #66 (2 X EOF)

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File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments

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156	67A	3.0,511.0	3,271	3,541	F. Stk	12	START OF REEL #67
157	67A	3.0,513.0	3,273	3,541	F. Stk	12	
158	67A	3.0,515.0	3,275	3,541	F. Stk	12	VP IS OFFSET 100 ft TO THE SOUTH
159	67A	3.0,517.0	3,277	3,541	F. Stk	12	
160	67A	3.0,519.0	3,279	3,541	F. Stk	12	
161	67A	3.0,521.0	3,281	3,541	F. Stk	12	
162	67A	3.0,523.0	3,283	3,541	F. Stk	12	
163	67A	3.0,525.0	3,285	3,541	F. Stk	12	
164	67A	3.0,527.0	3,287	3,541	F. Stk	12	
165	67A	3.0,529.0	3,289	3,541	F. Stk	12	VP IS OFFSET 100 ft NORTH
166	67A	3.0,531.0	3,291	3,541	F. Stk	12	VP IS OFFSET 100 ft NORTH
167	67A	3.0,533.0	3,293	3,541	F. Stk	12	
168	67A	3.0,535.0	3,295	3,541	F. Stk	12	END OF REEL #67 (2 X EOF)
169	68A	3.0,537.0	3,297	3,541	F. Stk	12	START OF REEL #68
170	68A	3.0,539.0	3,299	3,541	F. Stk	12	
171	68A	3.0,541.0	3,301	3,541	F. Stk	12	LAST VP of the day 11/9/94, END OF REEL #68

NOTE: DAILY TEST FILES 9015-9128 ON REEL #69.

172	70A	3.0,249.0	3,101	3,489	raw	1	NOISE STRIP, START OF NEW REEL #70

NOTE. START OF NEW DAY 11/10/94

173	70A	3.0,164.0	3,164	3,164	raw	1	Transformer test from the first shooter
174	70A	3.0,248.0	3,248	3,248	raw	1	Transformer test from the second shooter
175	70A	3.0,416.0	3,101	3,541	raw	1	VOID FILE
176	70A	3.0,416.0	3,101	3,541	raw	1	VOID FILE
177	70A	3.0,251.0	3,101	3,491	raw	1	
178	70A	3.0,253.0	3,101	3,493	raw	1	
179	70A	3.0,255.0	3,101	3,495	raw	1	
180	70A	3.0,257.0	3,101	3,497	raw	1	

NOTE. FFID 177-180 ARE POULTER SHOTS 40 LBS OVER 82.5 ft.

181	70A	3.0,416.0	3,101	3,541	raw	1	Shothole 311, 200 lbs @ 111 ft top, 200 ft bottom of charge.

NOTE. The line uphole is plugged into sta #416 @ the shot is located between flags 416 @ 417.

182	70A	3.0,259.0	3,101	3,499	raw	1	
183	70A	3.0,261.0	3,101	3,501	raw	1	
184	70A	3.0,263.0	3,101	3,503	raw	1	
185	70A	3.0,265.0	3,101	3,505	raw	1	
186	70A	3.0,267.0	3,101	3,507	raw	1	VOID FILE
187	70A	3.0,267.0	3,101	3,507	raw	1	
188	70A	3.0,269.0	3,101	3,509	raw	1	
189	70A	3.0,271.0	3,101	3,511	raw	1	END OF REEL #70 (2 X EOF)

NOTE. FFID 182-189 ARE POULTER SHOTS 40LBS OVER 82.5 ft.

190	71A	3.0,273.0	3,101	3,513	raw	1	START OF REEL #71

NOTE: FFID 190 IS A POULTER SHOT 40 LBS OVER 82.5 ft))

191	71A	3.0,275.0	3,101	3,515	raw	1	NOISE STRIP

NOTE: LAST SHOT OF THE DAY, DUE TO RAIN & WIND.

192	71A	3.0,124.0	3,124	3,124	raw	1	Transformer test with the first shooter

NOTE: START OF NEW DAY 11/11/94.

193	71A	3.0,276.0	3,276	3,276	raw	1	Transformer test with the second shooter
194	71A	3.0,124.0	3,101	3,541	raw	1	NOISE STRIP
195	71A	3.0,124.0	3,101	3,541	raw	1	SHOTHOLE 302-A, 50LBS @ 78 ftT, 100 ftB.

NOTE. The line uphole is plugged into sta #124 @ the shot is located between flags 124 @ 125.

196	71A	3.0,124.0	3,101	3,541	raw	1	Shothole 302-b, 100lbs @ 56 ft top, 100 ft bottom of charge.

NOTE. The line uphole is plugged into sta #124 @ the shot is located at the flag at 125.

197	71A	3.0,275.0	3,101	3,515	raw	1	
198	71A	3.0,277.0	3,101	3,517	raw	1	
199	71A	3.0,279.0	3,101	3,519	raw	1	
200	71A	3.0,281.0	3,101	3,521	raw	1	

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201	71A	3.0,283.0	3,101	3,523	raw	1	
202	71A	3.0,285.0	3,101	3,525	raw	1	
203	71A	3.0,287.0	3,101	3,527	raw	1	
204	71A	3.0,289.0	3,101	3,529	raw	1	
205	71A	3.0,291.0	3,101	3,531	raw	1	
206	71A	3.0,293.0	3,101	3,533	raw	1	END OF REEL #71(2 X EOF)

NOTE: FFID 197-206 ARE POULTER SHOTS 40 LBS OVER 82.5 ft.
NOTE:

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File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
207	72A	3.0,295.0	3,101	3,535	raw	1	START OF REEL #72.
208	72A	3.0,297.0	3,101	3,537	raw	1	

NOTE: FFID 207-208 ARE POULTER SHOTS 40 LBS OVER 82.5 ft.

209	72A	3.0,100.0	3,101	3,541	raw	1	Shothole 300, u.H.Time 38.0 ms, 200lbs @ 111 ft top, 200 ft bottom of charge.

NOTE: There is no line uphole. This shot is offset approx. 4 mi off end of line.

210	72A	3.0,299.0	3,101	3,539	raw	1	
211	72A	3.0,301.0	3,101	3,541	raw	1	
212	72A	3.0,303.0	3,101	3,541	raw	1	
213	72A	3.0,305.0	3,101	3,541	raw	1	
214	72A	3.0,307.0	3,101	3,541	raw	1	
215	72A	3.0,309.0	3,101	3,541	raw	1	
216	72A	3.0,313.0	3,101	3,541	raw	1	
217	72A	3.0,315.0	3,101	3,541	raw	1	

NOTE: FFID 210-217 ARE POULTERS SHOT 40 LBS OVER 82.5 ft
NOTE: FFID 216-217 ARE OVERLAP SHOTS.

218	72A	3.0,331.0	3,101	3,541	raw	1	Shothole 307, u.H.Time 34.0 ms, 200lbs @ 111 ft top, 200 ft bottom of charge

NOTE: The line uphole is plugged into sta. 331 & is located between flags 330 & 331

219	72A	3.0,331.0	3,101	3,541	raw	1	
220	72A	3.0,333.0	3,101	3,541	raw	1	
221	72A	3.0,339.0	3,101	3,541	raw	1	
222	72A	3.0,341.0	3,101	3,541	raw	1	
223	72A	3.0,343.0	3,103	3,541	raw	1	END OF REEL #72 (2 X EOF)

NOTE: FFID 219-223 ARE MINIHOLE PATTERNS, 5 HOLES X 2LBS OVER 82.5 ft

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File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
224	73A	3.0,345.0	3,105	3,541	raw	1	START OF REEL #73
225	73A	3.0,347.0	3,107	3,541	raw	1	
226	73A	3.0,349.0	3,109	3,541	raw	1	
227	73A	3.0,351.0	3,111	3,541	raw	1	
228	73A	3.0,353.0	3,113	3,541	raw	1	
229	73A	3.0,355.0	3,115	3,541	raw	1	
230	73A	3.0,357.0	3,117	3,541	raw	1	
231	73A	3.0,359.0	3,119	3,541	raw	1	
232	73A	3.0,361.0	3,121	3,541	raw	1	
233	73A	3.0,363.0	3,123	3,541	raw	1	
234	73A	3.0,365.0	3,125	3,541	raw	1	
235	73A	3.0,366.0	3,126	3,541	raw	1	
236	73A	3.0,367.0	3,127	3,541	raw	1	4 HOLE PATTERN: 1 HOLE HAS A BAD CAP
237	73A	3.0,368.0	3,128	3,541	raw	1	
238	73A	3.0,369.0	3,129	3,541	raw	1	
239	73A	3.0,370.0	3,130	3,541	raw	1	
240	73A	3.0,371.0	3,131	3,541	raw	1	END OF REEL #73

NOTE: FFID 224-240 ARE MINIHOLE PATTERNS, 5 HOLES X 2LBS. OVER 82.5 FT.

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File	Reel	VIB POINT	First Chan	Last Channel	Type	SWEEPS	Comments
241	74A	3.0,385.0	3,145	3,541	raw	1	4 hole pattern 1 hole has a bad cap. Start Of Reel #74
242	74A	3.0,386.0	3,146	3,541	raw	1	VOID FILE
243	74A	3.0,386.0	3,146	3,541	raw	1	4 HOLE PATTERN 1 HOLE HAS A BAD CAP
244	74A	3.0,387.0	3,147	3,541	raw	1	
245	74A	3.0,388.0	3,148	3,541	raw	1	
246	74A	3.0,389.0	3,149	3,541	raw	1	
247	74A	3.0,390.0	3,150	3,541	raw	1	
248	74A	3.0,391.0	3,151	3,541	raw	1	STA #343 WENT OPEN
249	74A	3.0,393.0	3,153	3,541	raw	1	3 HOLE PATTERN 2 HOLES HAD BAD CAPS.
250	74A	3.0,395.0	3,155	3,541	raw	1	
251	74A	3.0,397.0	3,157	3,541	raw	1	
252	74A	3.0,399.0	3,159	3,541	raw	1	
253	74A	3.0,401.0	3,161	3,541	raw	1	
254	74A	3.0,403.0	3,163	3,541	raw	1	4 HOLE PATTERN 1 HOLE HAS A BAD CAP.
255	74A	3.0,405.0	3,165	3,541	raw	1	
256	74A	3.0,407.0	3,167	3,541	raw	1	
257	74A	3.0,409.0	3,169	3,541	raw	1	
258	74A	3.0,411.0	3,171	3,541	raw	1	
259	74A	3.0,413.0	3,173	3,541	raw	1	
260	74A	3.0,415.0	3,175	3,541	raw	1	
261	74A	3.0,416.0	3,176	3,541	raw	1	STA #343 IS GOOD NOW
262	74A	3.0,417.0	3,177	3,541	raw	1	END OF REEL #74 (2 X EOF)

NOTE. FFID 243-262 are minihole patterns, 5 holes x 2lbs. over 82.5 ft.

263	75A	3.0,424.0	3,184	3,541	raw	1	START OF REEL #75.
264	75A	3.0,425.0	3,185	3,541	raw	1	4 HOLE PATTERN 1 HOLE HAS A BAD CAP
265	75A	3.0,426.0	3,186	3,541	raw	1	
266	75A	3.0,427.0	3,187	3,541	raw	1	
267	75A	3.0,429.0	3,189	3,541	raw	1	STA #409 WENT OPEN
268	75A	3.0,431.0	3,191	3,541	raw	1	
269	75A	3.0,433.0	3,193	3,541	raw	1	
270	75A	3.0,435.0	3,195	3,541	raw	1	
271	75A	3.0,437.0	3,197	3,541	raw	1	
272	75A	3.0,439.0	3,199	3,541	raw	1	Last shot on LINE #3. END OF REEL #75 (2 X EOF)

NOTE. FFID 263-272 are minihole patterns, 5 holes x 2lbs. Over 82.5 ft.

End of OBSERVER data

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Figure Captions

Figure 1A. Regional map of Yucca Mountain area, Nevada, showing seismic Lines 2 and 3 and line AV-1 in the Amargosa Desert relative to Yucca Mountain and other structures described in the text. Modified from Brocher and others [1993]. Outcrops of pre-Pliocene rocks are shaded.

Figure 1B. Map of the vicinity of Yucca Mountain showing location of seismic Lines 2 and 3. Larger numbers along lines provide station numbers; smaller numbers provide shot hole locations. Dark shaded features in Crater Flat show lava flows and basaltic cones. Selected faults are shown, including the Crater Flat fault (CFF), the Windy Wash fault (WWF), the Fatigue Wash fault (FWF), the Solitario Canyon fault (SCF), the Ghost Dance fault (GDF), the Bow Ridge fault (BRF), the Midway Valley fault (MVF), and the Paintbrush Canyon fault (PCF). Drill holes USW VH-1, USW WT-7, USW H-6, and UE-25 p#1 are also shown.

Figures 2A to 2I. Geophone and source patterns tested during noise study and used during acquisition (production) of Lines 2 and 3. Patterns B, C, D, and F were used during acquisition of Lines 2 and 3. Station flag for each pattern is at 0 ft.

Figure 3. Common source gathers from parameter testing from Vibrator Points (VPs) at (A and B) St. 752. Each source gather shows the output recorded by the three geophone arrays tested: weighted inline array, potted geophones, and linear inline array. Figures 3A and 3B compare bumper-to-bumper vibrator array without move-up versus the 225-ft-long production pattern with 11 move-ups. Each record was obtained using 12 sweeps, 10 to 50 Hz, and 12 s sweeps. Data were recorded summed and correlated but are otherwise unprocessed.

Figure 4. Common source gathers from parameter testing from Vibrator Points (VPs) at (A and B) St. 652. Each source gather shows the output recorded by the three geophone arrays tested: weighted inline array, potted geophones, and linear inline array. Figures 4A and 4B compare a 225 ft vibrator pattern with move-ups between each sweep with a 165-ft-long vibrator pattern with move-up after every other sweep. Each record was obtained using 12 sweeps, 10 to 50 Hz, and 8 s sweeps. Data were recorded summed and correlated but are otherwise unprocessed.

Figures 5A to 5E. Wind speed data (in m/s) recorded at Yucca Mountain (figs. 5A to 5C), NTS-60 (fig. 5D), and Knothead Gap (fig. 5E) during seismic field work. Data for each seismic line are plotted against Julian day; corresponding calendar days are also indicated. Data at Yucca Mountain and Knothead Gap were recorded at 10 minute intervals; data at NTS-60 were recorded hourly. Wind speed values in excess of 12 m/s indicate missing wind speed data for that time.

Figure 6. Comparison of shot records obtained using vibrator and Poulter sources at St. 941 on Line 2. Records are unprocessed apart from vibroseis correlation.

Figure 7. Comparison of shot records obtained using vibrator and minihole sources at St. 416 on Line 3. Records are unprocessed apart from vibroseis correlation.

Figure 8. Stacking velocities used for (A) Line 2 and (B) Line 3, superimposed on the final section of each line. Velocities are shown in terms of two-way travel time and CDP number. 80 CDPs equal one km.

Figure 9. Well logs and synthetic seismograms for seven wells along Lines 2 and 3. For each well the sonic log (in microseconds/ft), density log (in kg/m^3), reflection coefficients, and synthetic seismograms are provided both as functions of two-way travel time and depth.

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Seismograms were calculated using a 30-Hz Ricker wavelet. Wells are: (A) USW VH-1, (B) USW WT-7, (C) USW UZ-6, (D) USW H-4, (E) UE-25 UZ-16, (F) USW H-6, and (g) UE-25 p#1.

Figure 10. Final, uninterpreted section for seismic reflection Line 2. The processing used to generate this section is described in the text and Table 10. 40 stations (80 CDPs) equal one km.

Figure 11. Final, uninterpreted section for seismic reflection Line 3. The processing used to generate this section is described in the text and Table 10. 40 stations (80 CDPs) equal one km.

Figure 12. Final depth-converted section for Line 2, uninterpreted. The depth-converted section is plotted without vertical exaggeration. The processing used to generate this section is described in the text and Table 10. 40 stations (80 CDPs) equal one km.

Figure 13. Final depth-converted section for Line 3, uninterpreted. The depth-converted section is plotted without vertical exaggeration. The processing used to generate this section is described in the text and Table 10. 40 stations (80 CDPs) equal one km.

Figure 14. Final migrated, depth-converted section for Line 2, uninterpreted. The processing used to generate this section is described in the text and Table 10. 40 stations (80 CDPs) equal one km.

Figure 15. Final migrated, depth-converted section for Line 3, uninterpreted. The processing used to generate this section is described in the text and Table 10. 40 stations (80 CDPs) equal one km.

Figure 16. Final migrated, depth-converted section for Line 2, interpreted. The processing used to generate this section is described in the text and Table 10. 40 stations (80 CDPs) equal one km. Circle patterned line located between Red Cone and Windy Wash fault and between the unconformity and inferred top of Paleozoic section represents inferred Tertiary units.

Figure 17. Final migrated, depth-converted section for Line 3, interpreted. The processing used to generate this section is described in the text and Table 10. 40 stations (80 CDPs) equal one km.

Figure 18. Uninterpreted section produced by intermediate processing of Line 2 showing section down to 8 s. This section has not been depth-converted, and does not include final stacking velocities and statics. 40 stations (80 CDPs) equal one km.

Figure 19. Isostatic gravity anomaly model for Line 2. The start of the seismic line (St. 101) is at model km 0, the end of the seismic line (St. 1133) is at km 26. Models include: (A) a single step in the top of Paleozoic basement beneath Yucca Mountain, and (B) two steps in top of Paleozoic basement beneath Yucca Mountain. Layer densities are given in g/cm^3. Zero elevation on the depth model corresponds to sea level. Geographic and borehole features are given for reference; fault is abbreviated as "f".

Figure 20. Ground magnetic anomaly data along Line 2. The start of seismic Line 2 is at 0 km, and the end of the line is at km 26. Note the short wavelength anomalies in the eastern half of Crater Flat and at Yucca Mountain. Powerlines near Highway 95 cause large anomalies at km 3.2.

Figure 21. Isostatic gravity anomaly model for Line 3. The start of the seismic line (St. 101) is at km 0, the end of the seismic line (St. 541) is at km 11. Model is constrained by depth to Paleozoic at UE-25 p#1. Models include: (A) a single step in the top of Paleozoic basement beneath Yucca

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Mountain, and (B) two steps in top of Paleozoic basement beneath Yucca Mountain. Layer densities are given in g/cm^3. Zero elevation on the depth model corresponds to sea level. Abbreviation "f" denotes fault.

Figure 22 Ground magnetic anomaly data along Line 3. The start of seismic Line 3 is at 0 km, and the end of the line is at km 11. Note the absence of any significant anomaly over Fortymile Wash and presence of anomalies at wells along the line.

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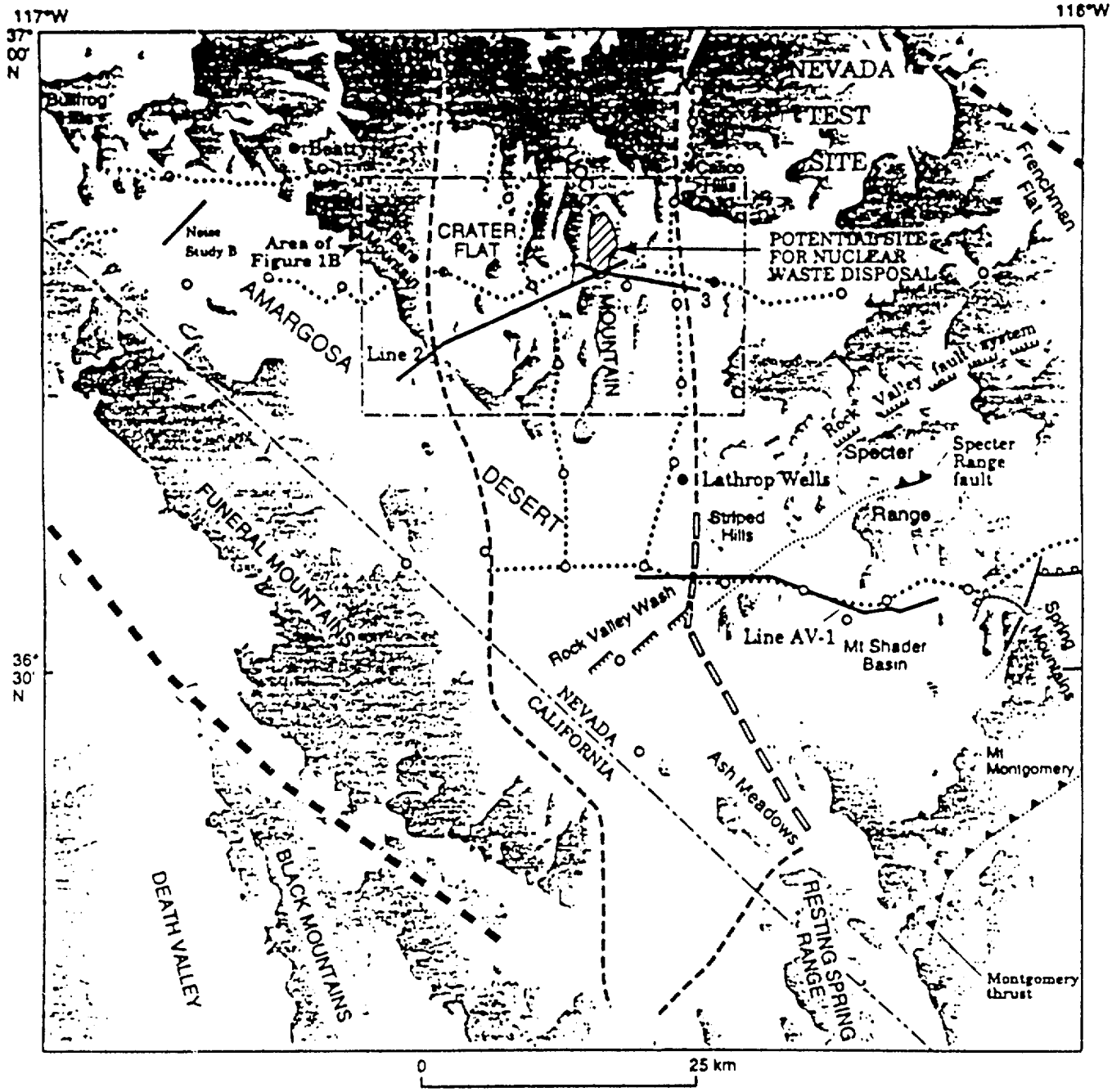

EXPLANATION

- Approximate boundary of the Amargosa Desert structural trough
- Boundary of Walker Lane from Carr [1990]
- Thrust fault Sawteeth on upper plate; dotted where concealed
- Point of Rocks fault Hachures on upper plate; Dotted where concealed
- "Gravity fault" from Winograd and Thordarson [1975]
- Quaternary fault scarp (shown only in and near area of Mt. Shader Basin)
- Seismic reflection line
- Seismic refraction line (shot points shown as circles) from Mooney and Schapper [1995]

Figure 1A. Regional map of Yucca Mountain area, Nevada, showing seismic lines 2 and 3 and line AV-1 in the Amargosa Desert relative to Yucca Mountain and other structures described in the text. Map modified from Brocher and others [1993]. Outcrops of pre-Pliocene rocks are shaded.

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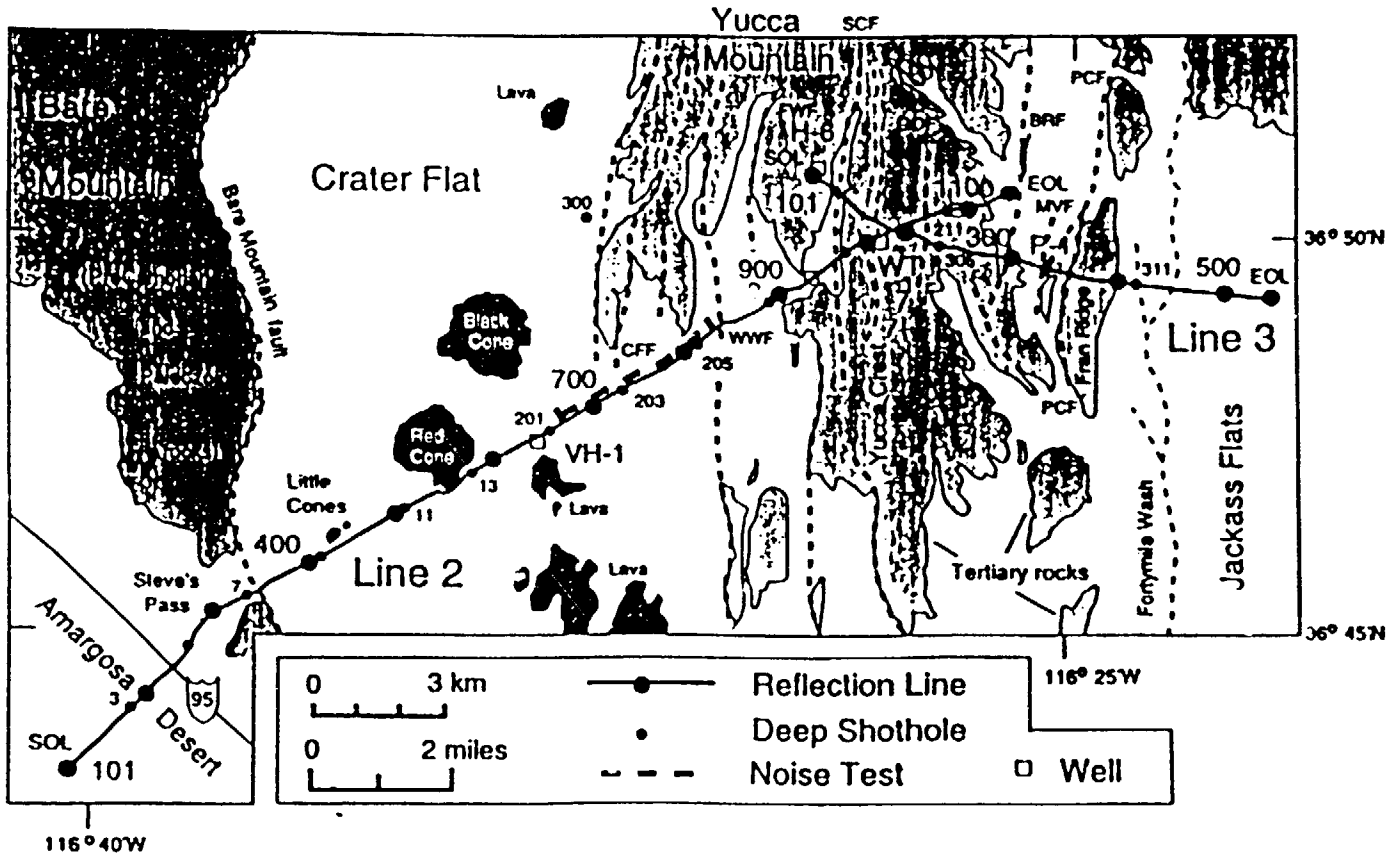

Figure 1B. Map of the vicinity of Yucca Mountain showing location of seismic lines 2 and 3. Larger numbers along lines provide station numbers, smaller numbers provide shothole locations. Dark shaded features in Crater Flat show lava flows and basaltic cones. Selected faults are shown, including the Crater Flat fault (CFF), the Windy Wash fault (WWF), the Fatigue Wash fault (FWF), the Solitario Canyon fault (SCF), the Ghost Dance fault (GDF), the Bow Ridge fault (BRF), the Midway Valley fault (MVF), and the Paintbrush Canyon fault (PCF). Drill holes USW VH-1, USW WT-7, USW H-6, and UE-25 p#1 are also shown.

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Source and Receiver Patterns

Yucca Mountain Project Lines 2 and 3

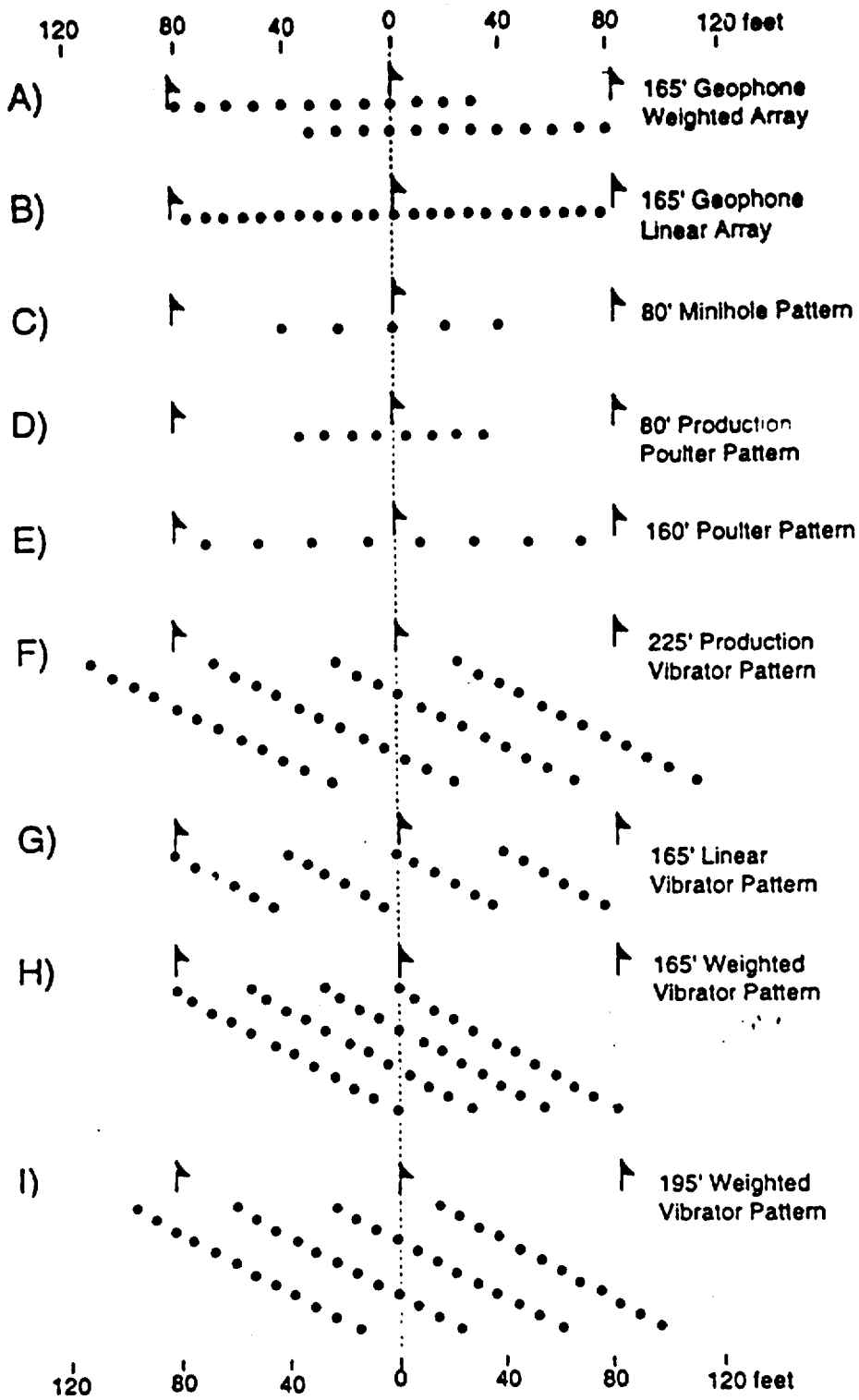

Figure 2. Geophone and source patterns tested during the noise study and used during the acquisition of Lines 2 and 3. Patterns B, C, D, and F were used during the acquisition of Lines 2 and 3. Station flag for each pattern is at 0 feet.

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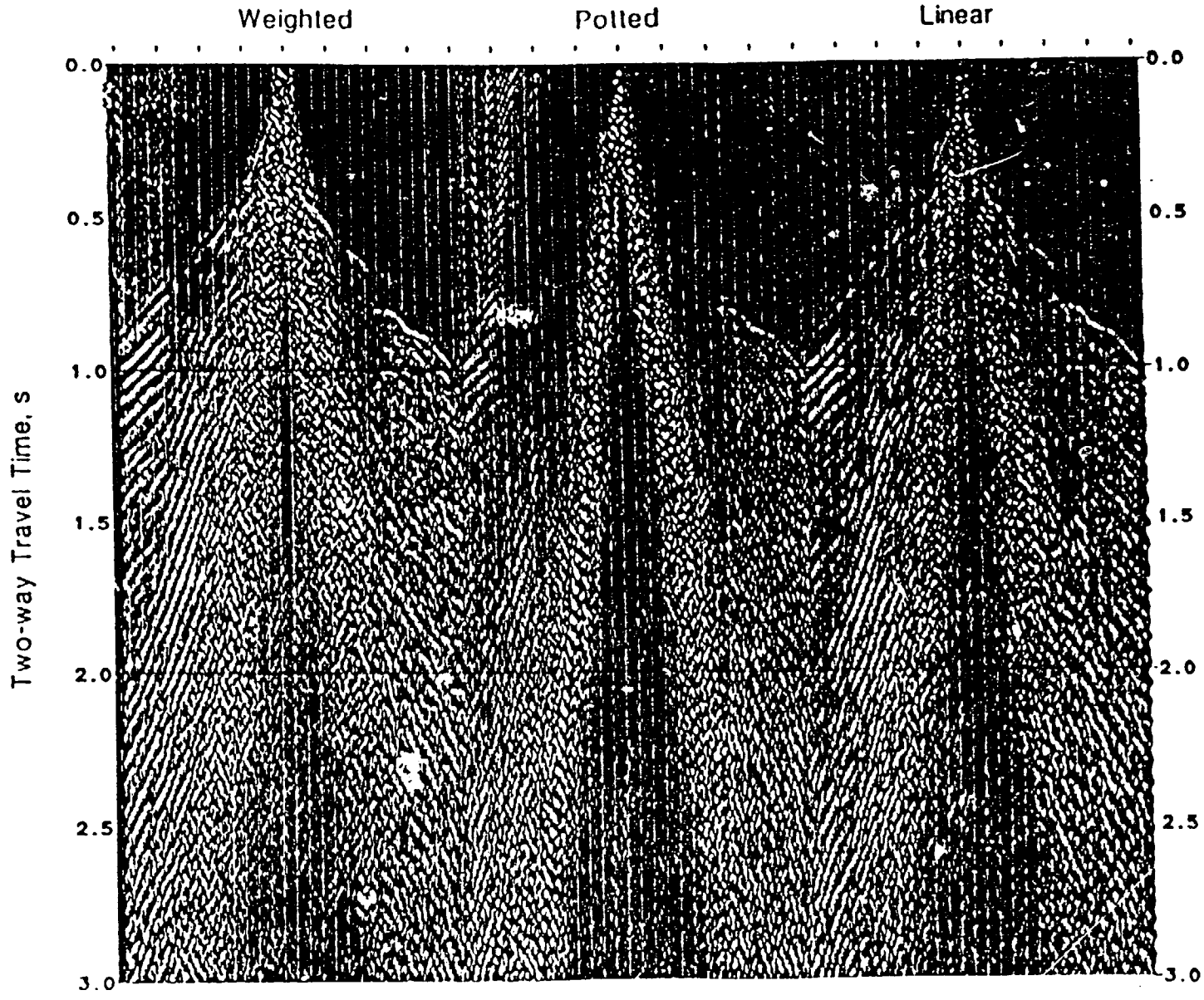

A)

Fig. 3

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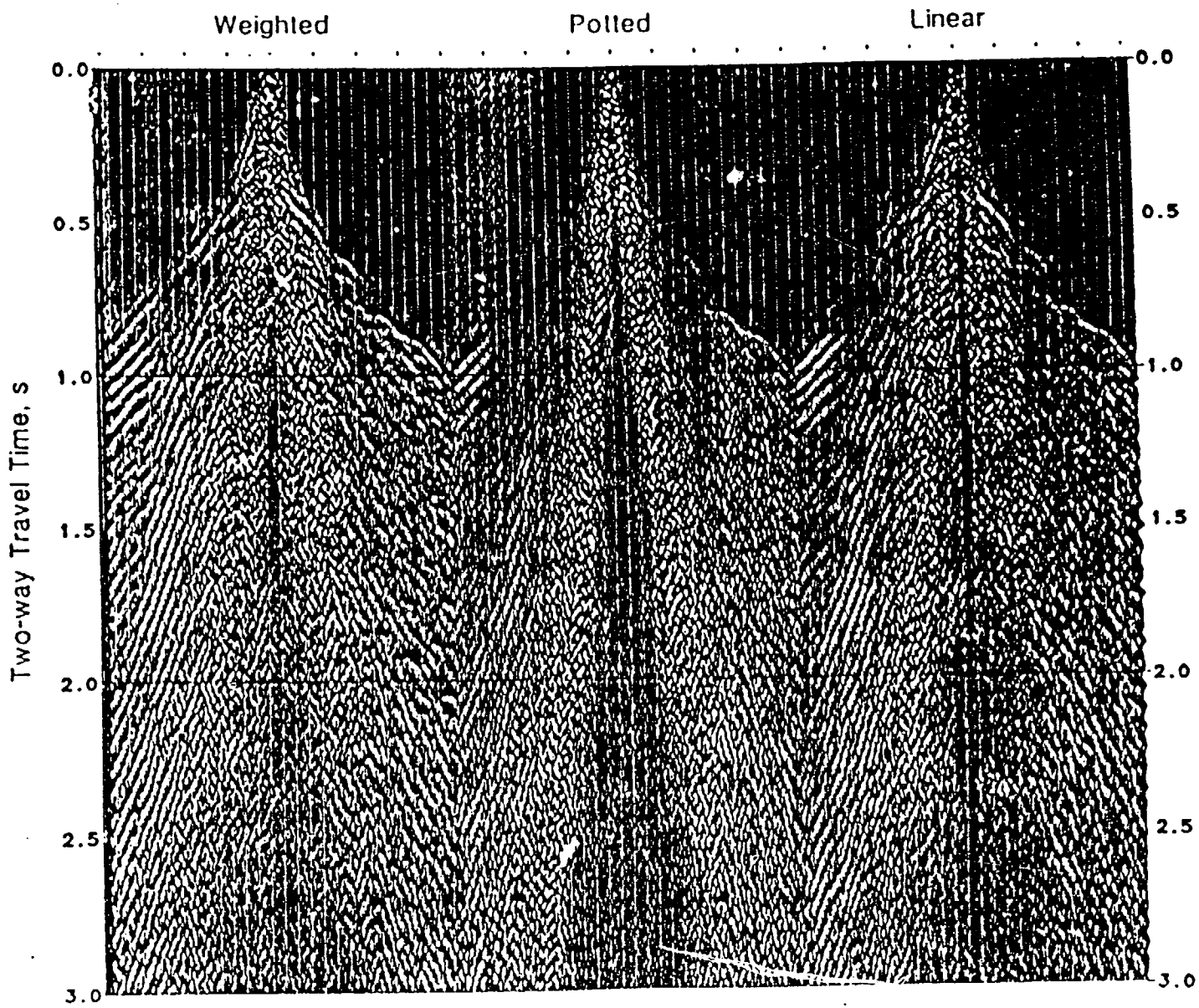

B)

Fig. 3

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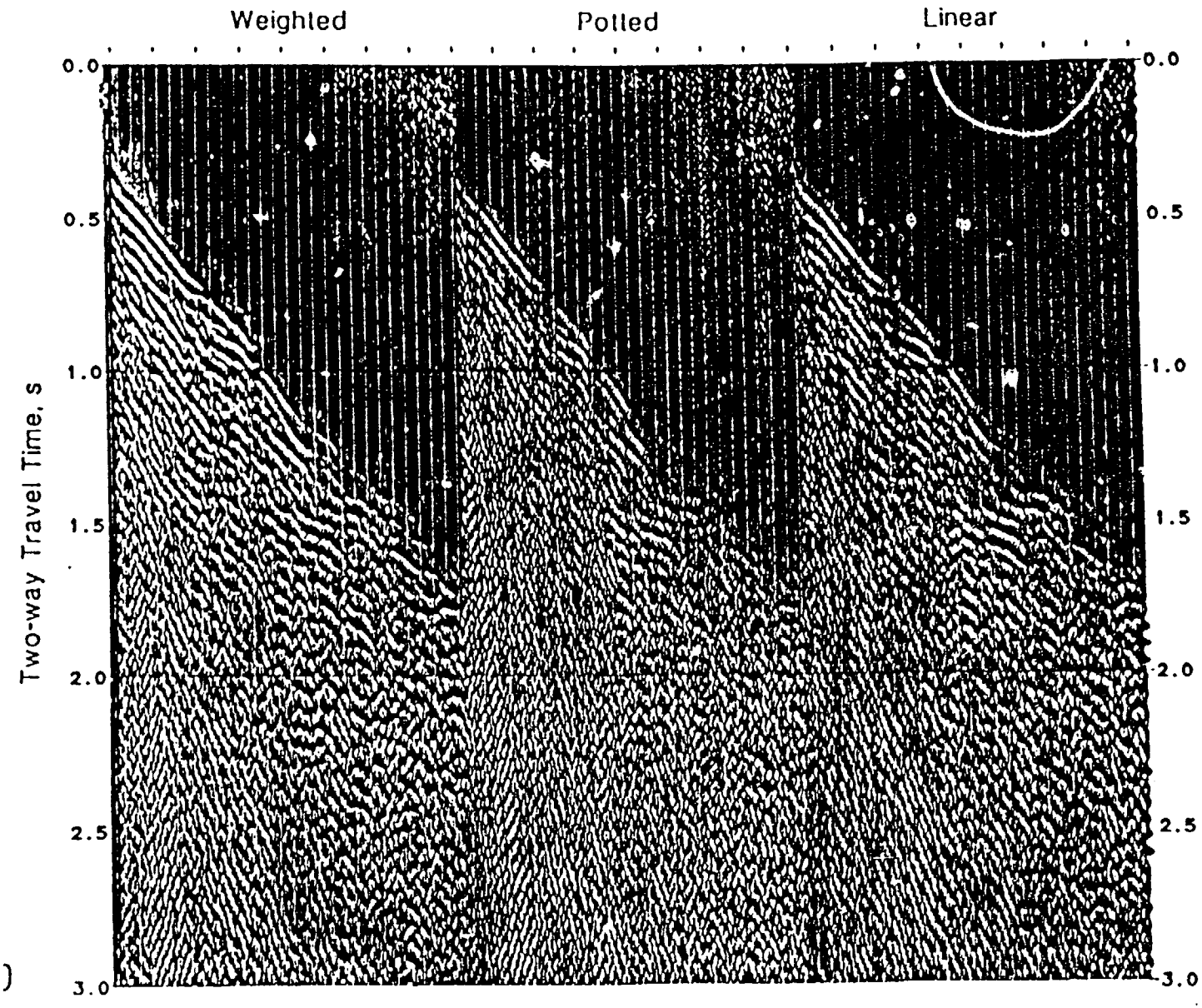

A)

Fig. 4

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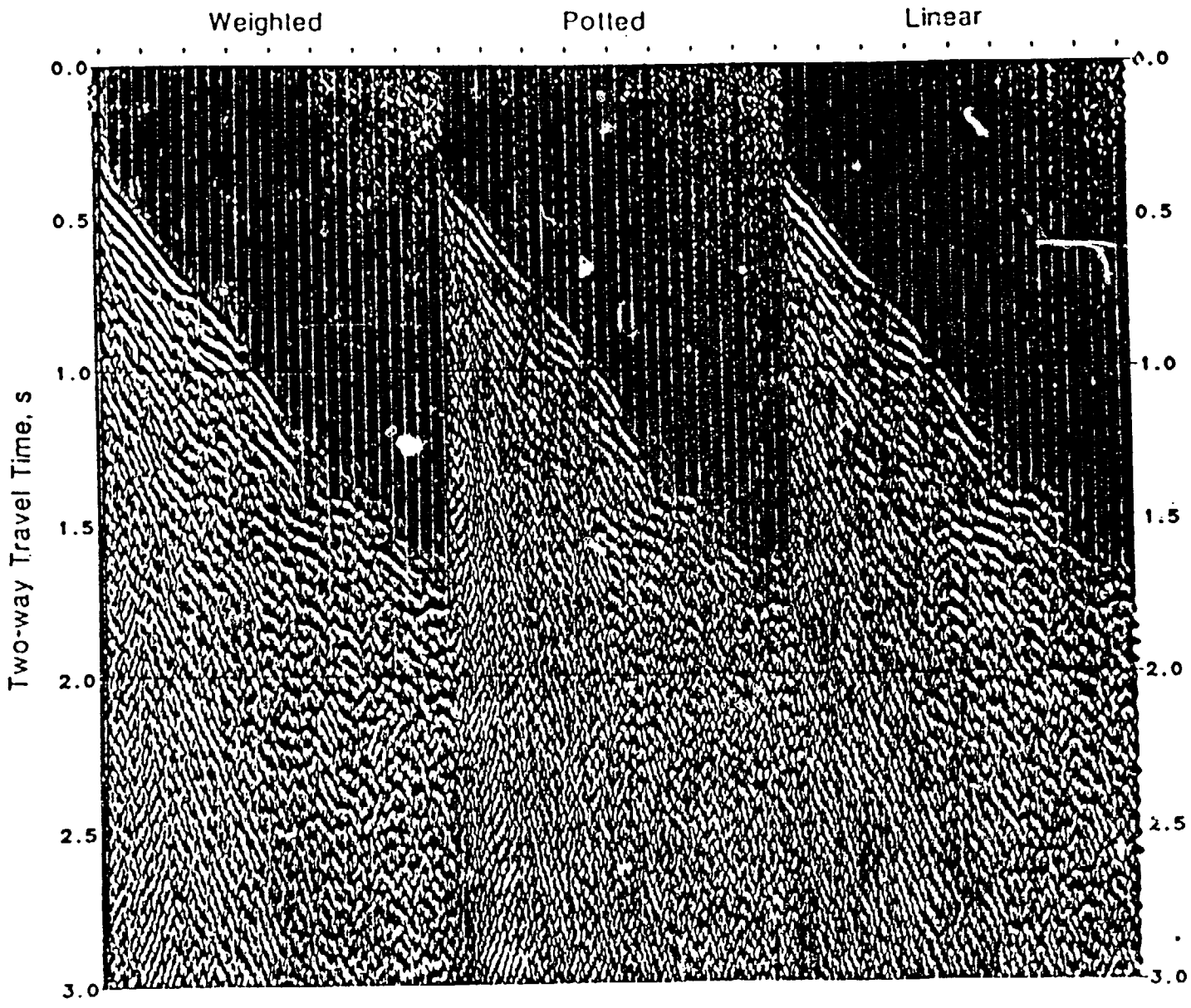

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Fig. 4

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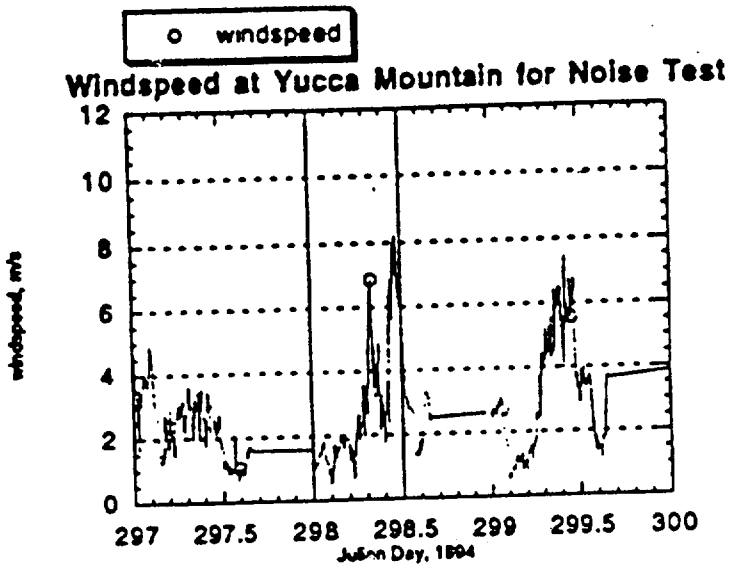
A)



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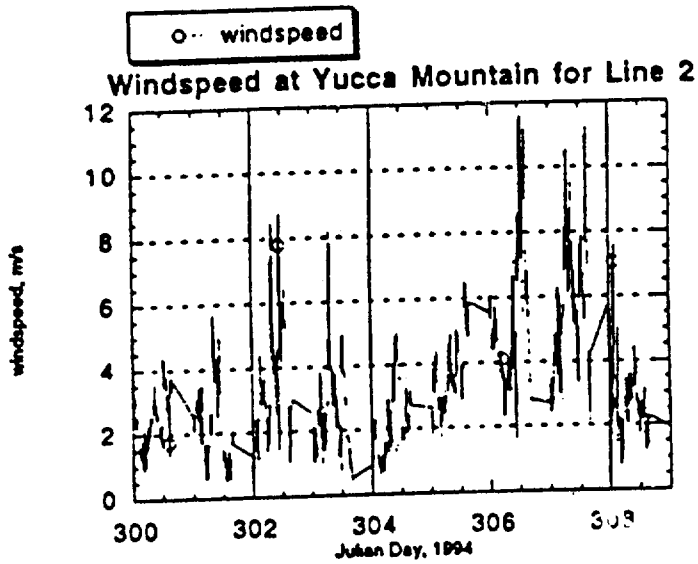

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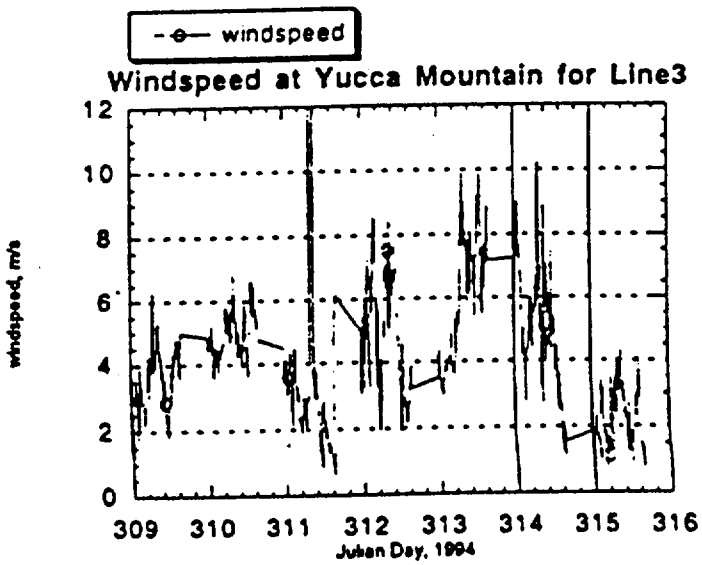

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Fig. 5

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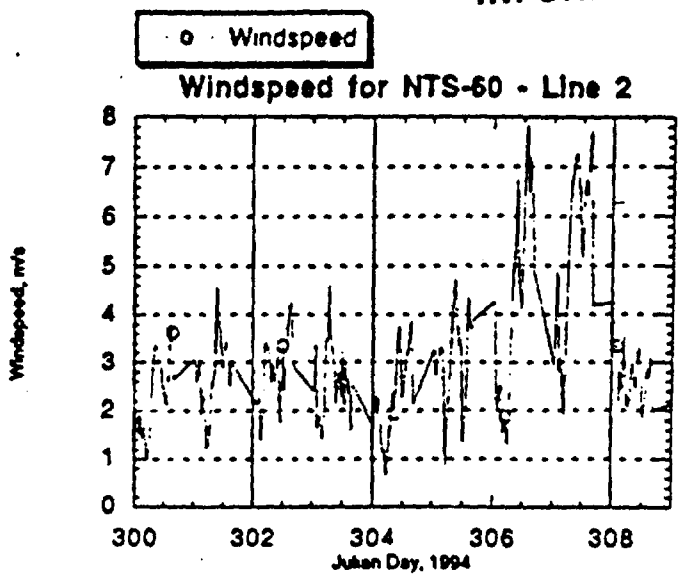
D)



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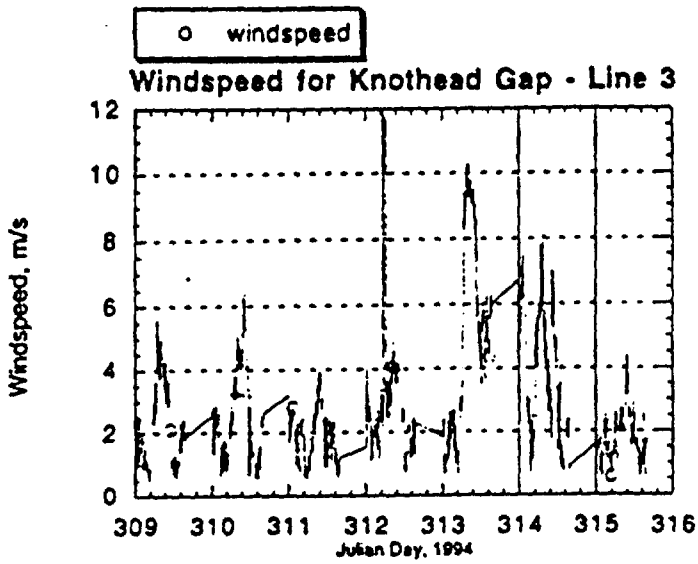

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Fig. 5

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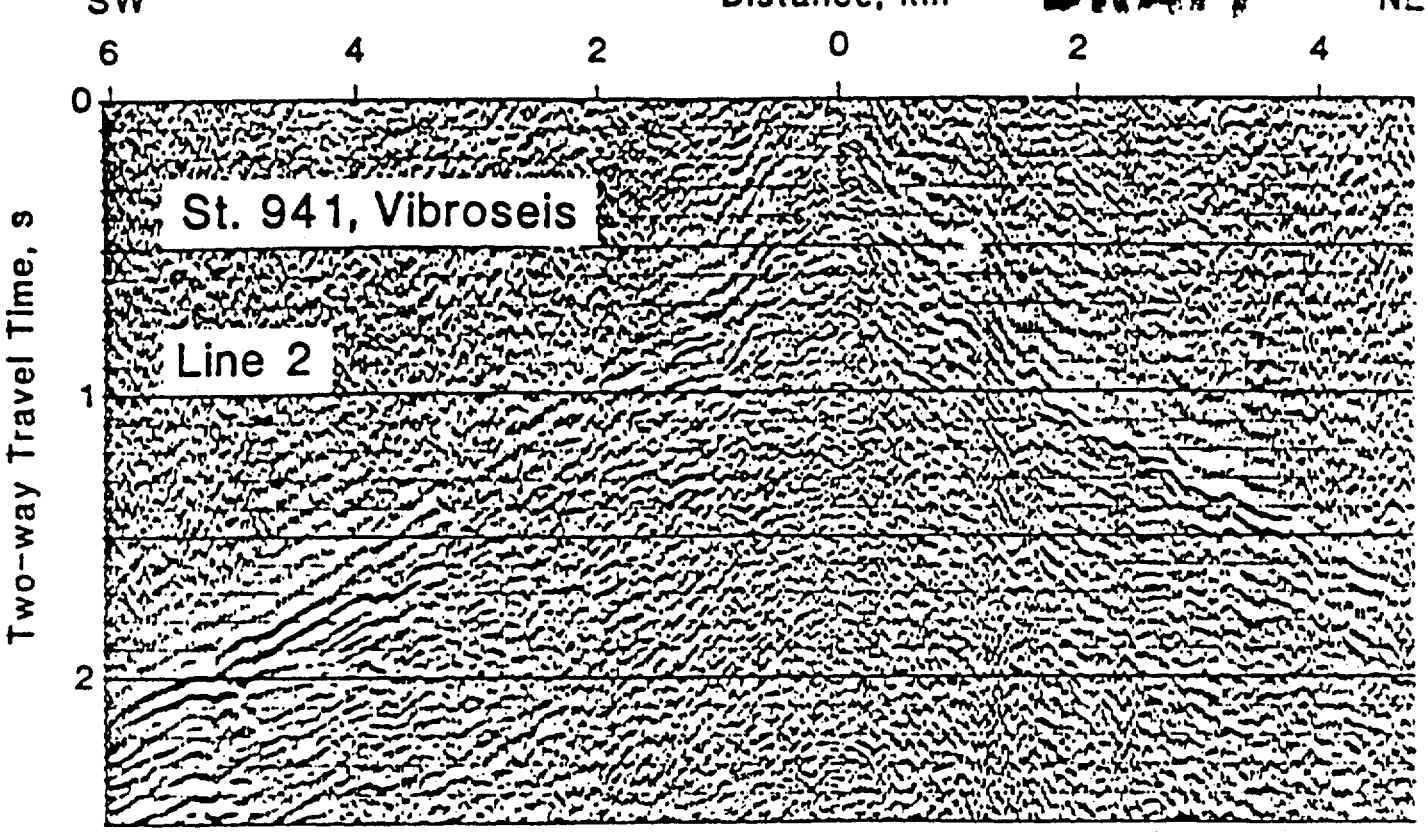

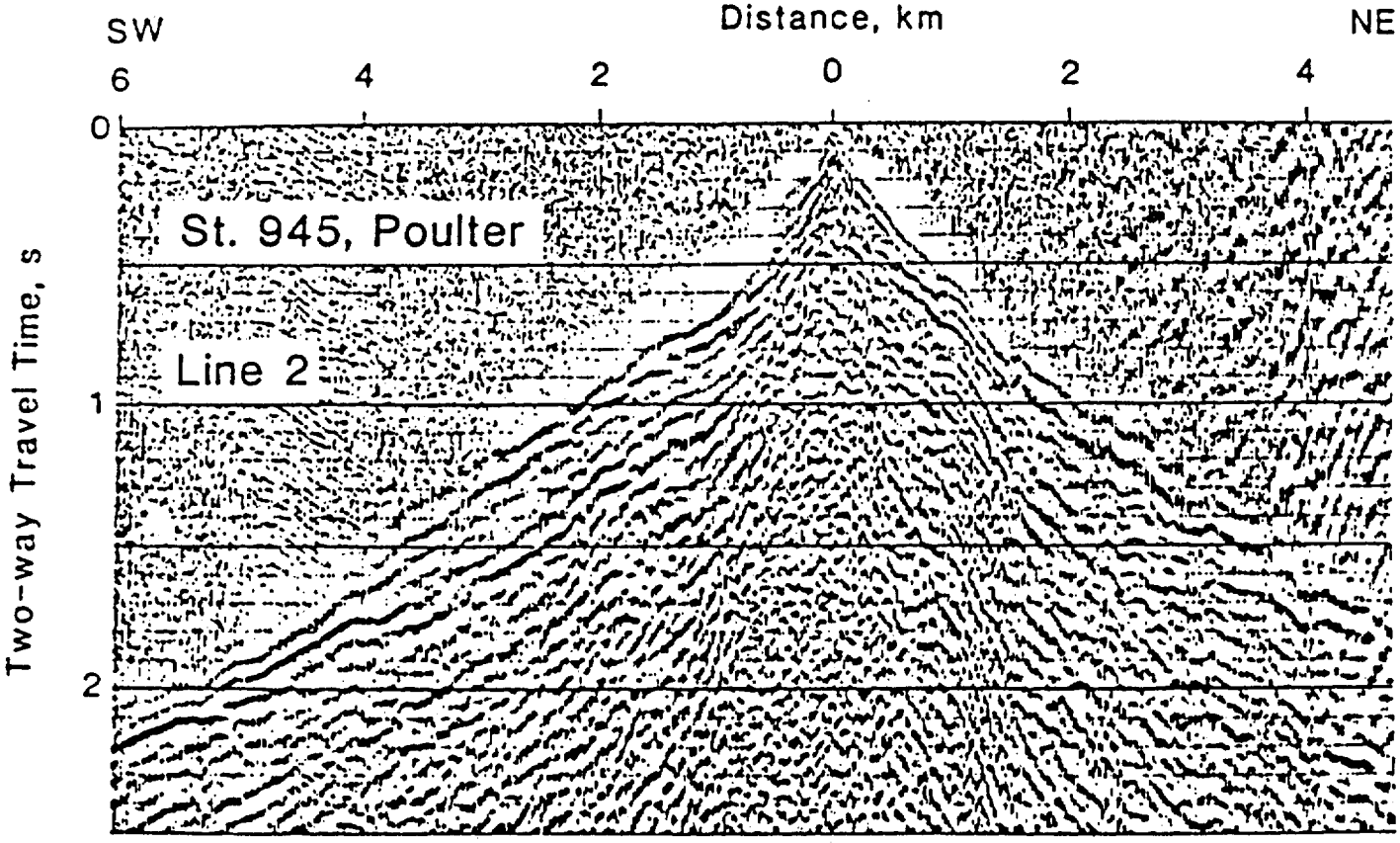

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Fig. 6

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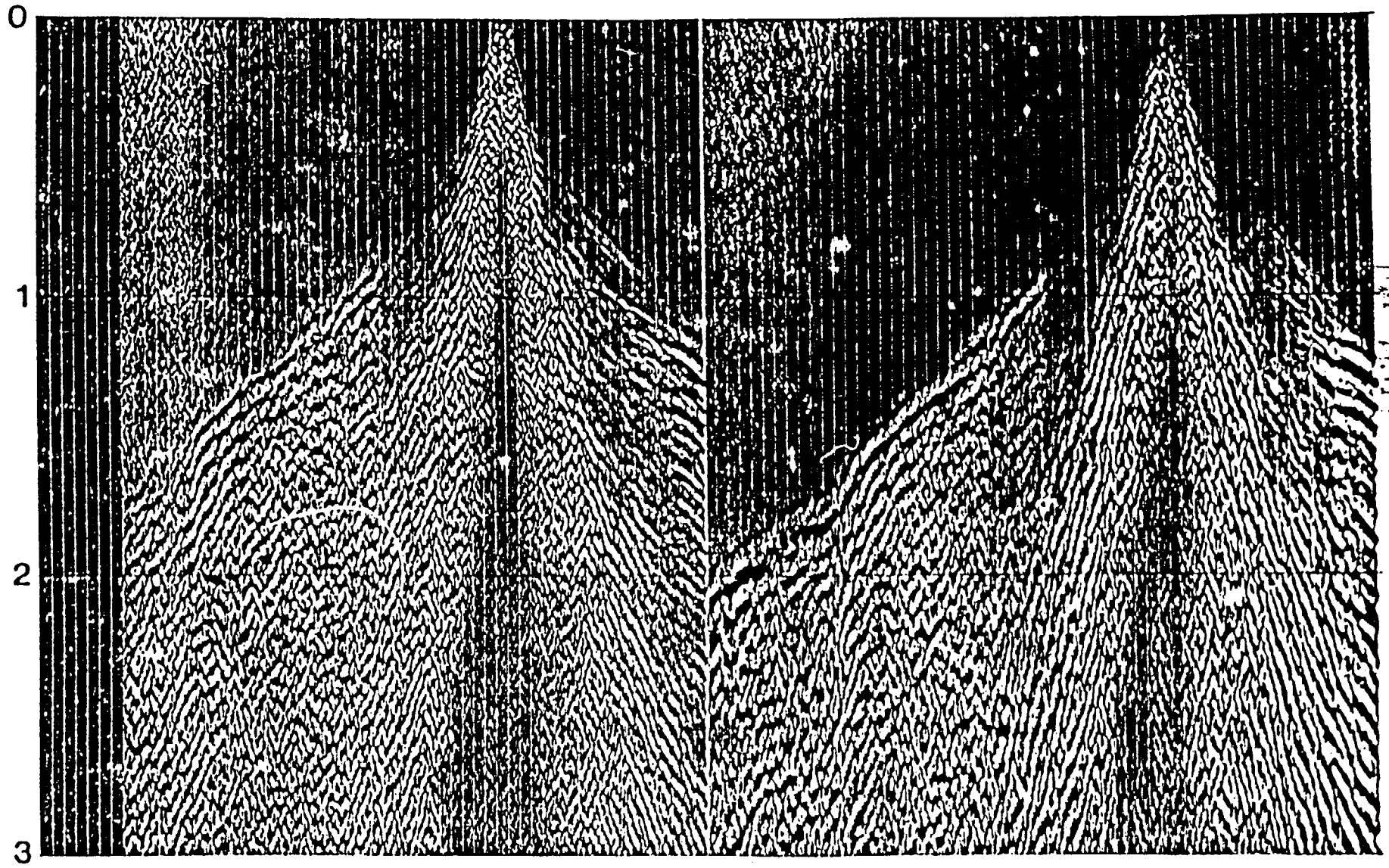

Fig. 7

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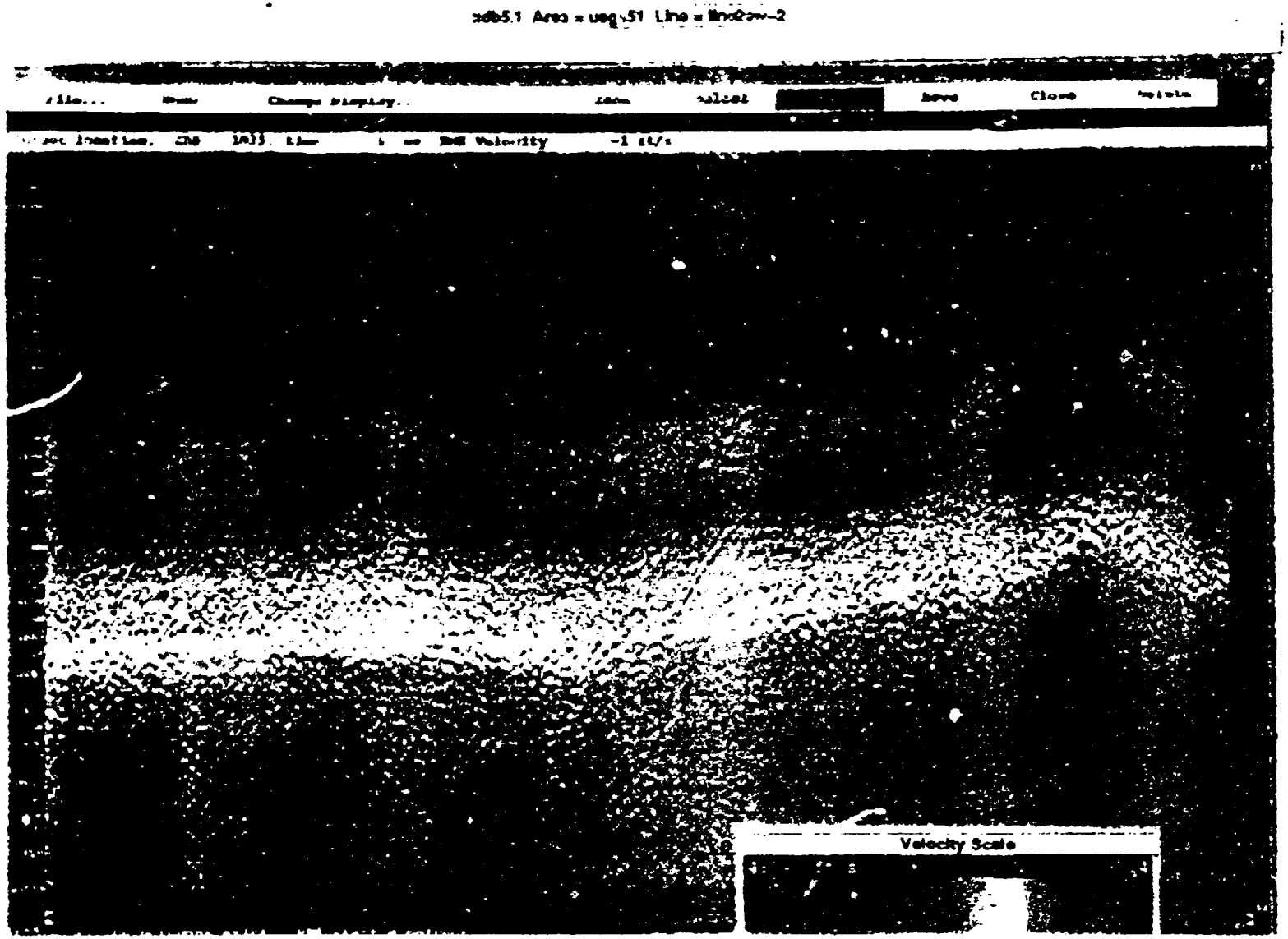

Figure 8A. Stacking velocities used for (A) Line 2, and (B) Line 3, superimposed on the final section of each line. Velocities are shown in terms of two-way travel time and CDP number. 80 CDPs equal one km.

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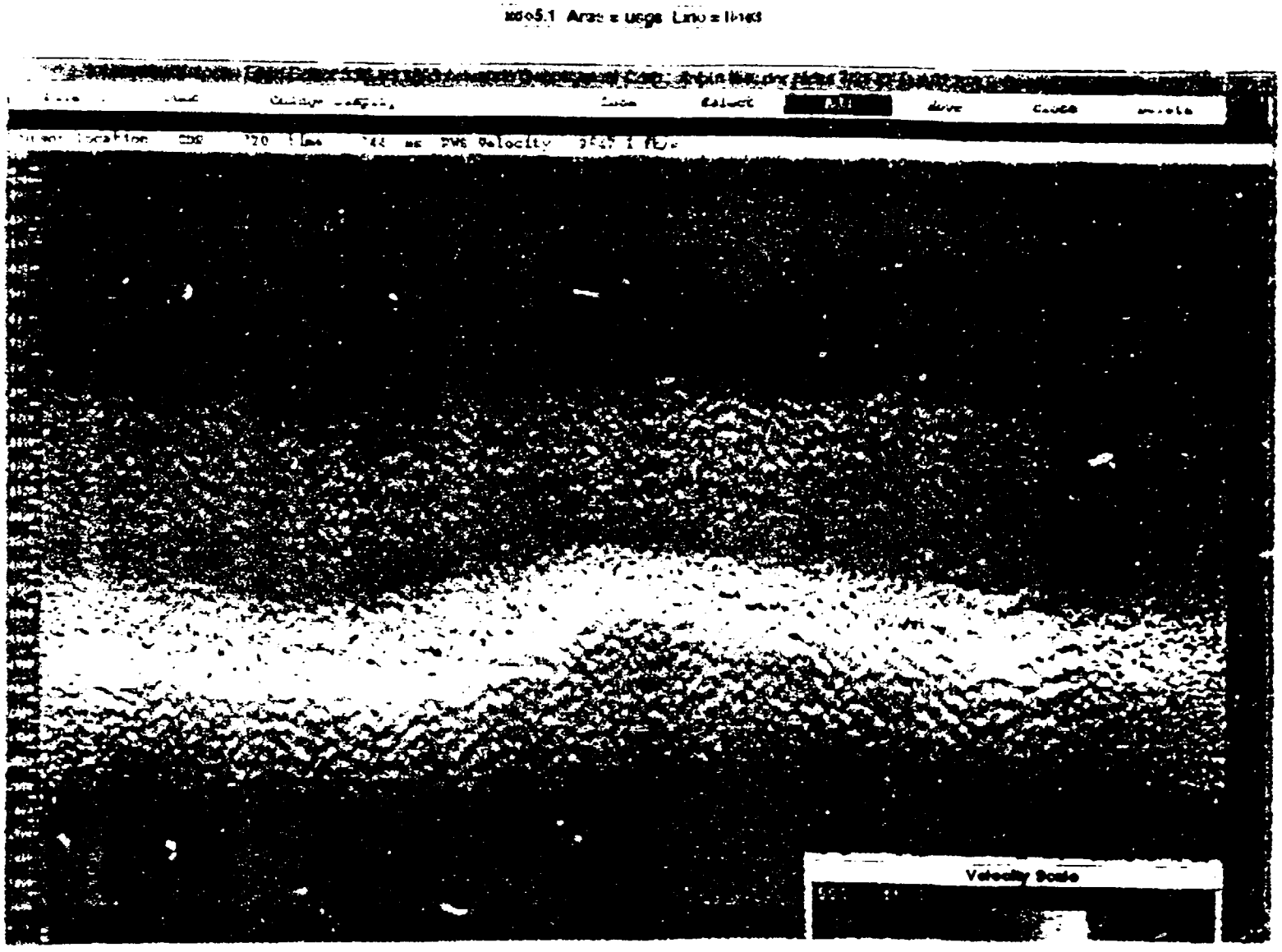

Figure 8B. Stacking velocities used for (A) Line 2, and (B) Line 3, superimposed on the final section of each line. Velocities are shown in terms of two-way travel time and CDP number. 80 CDPs equal one km

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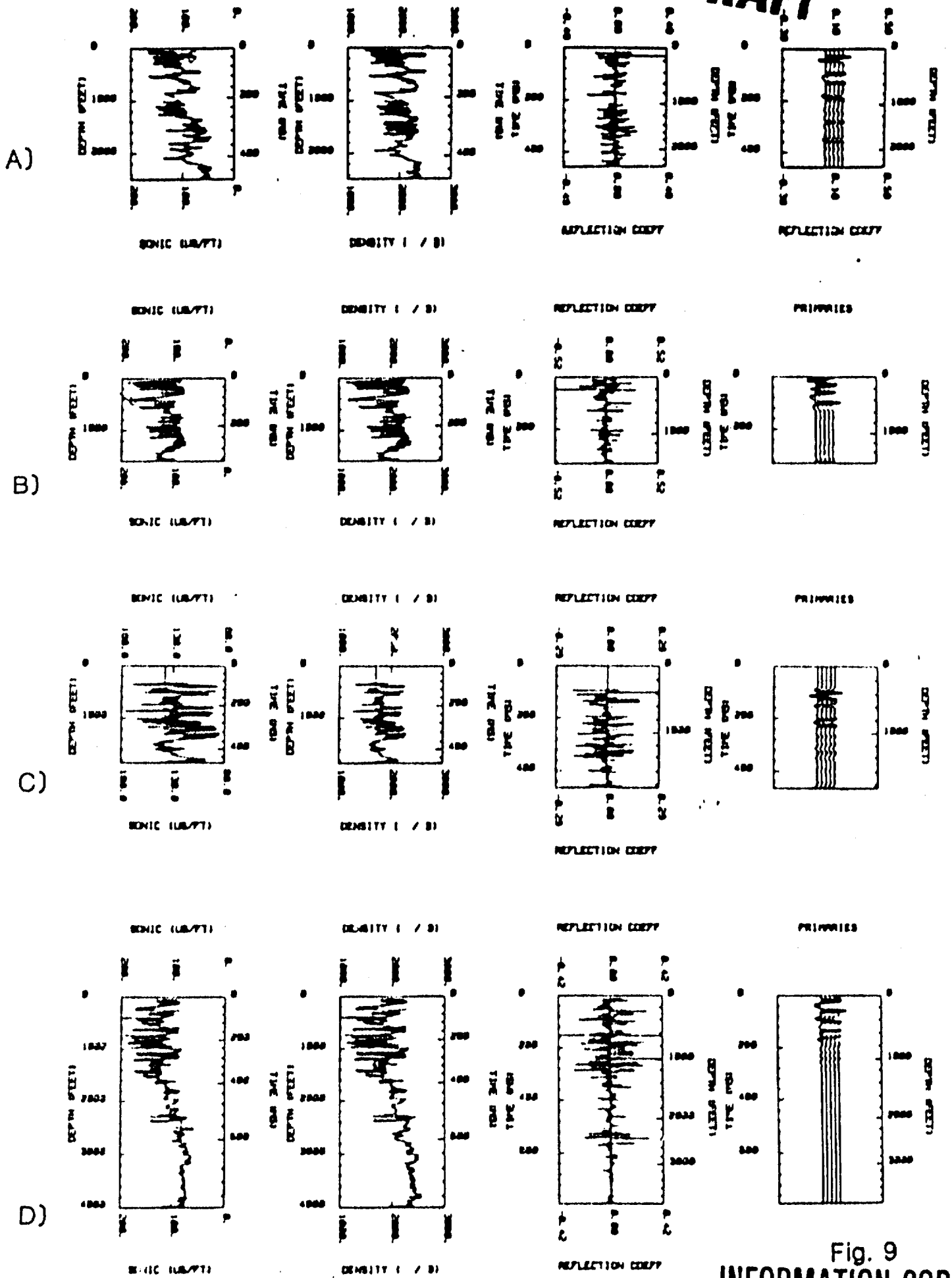

Fig. 9

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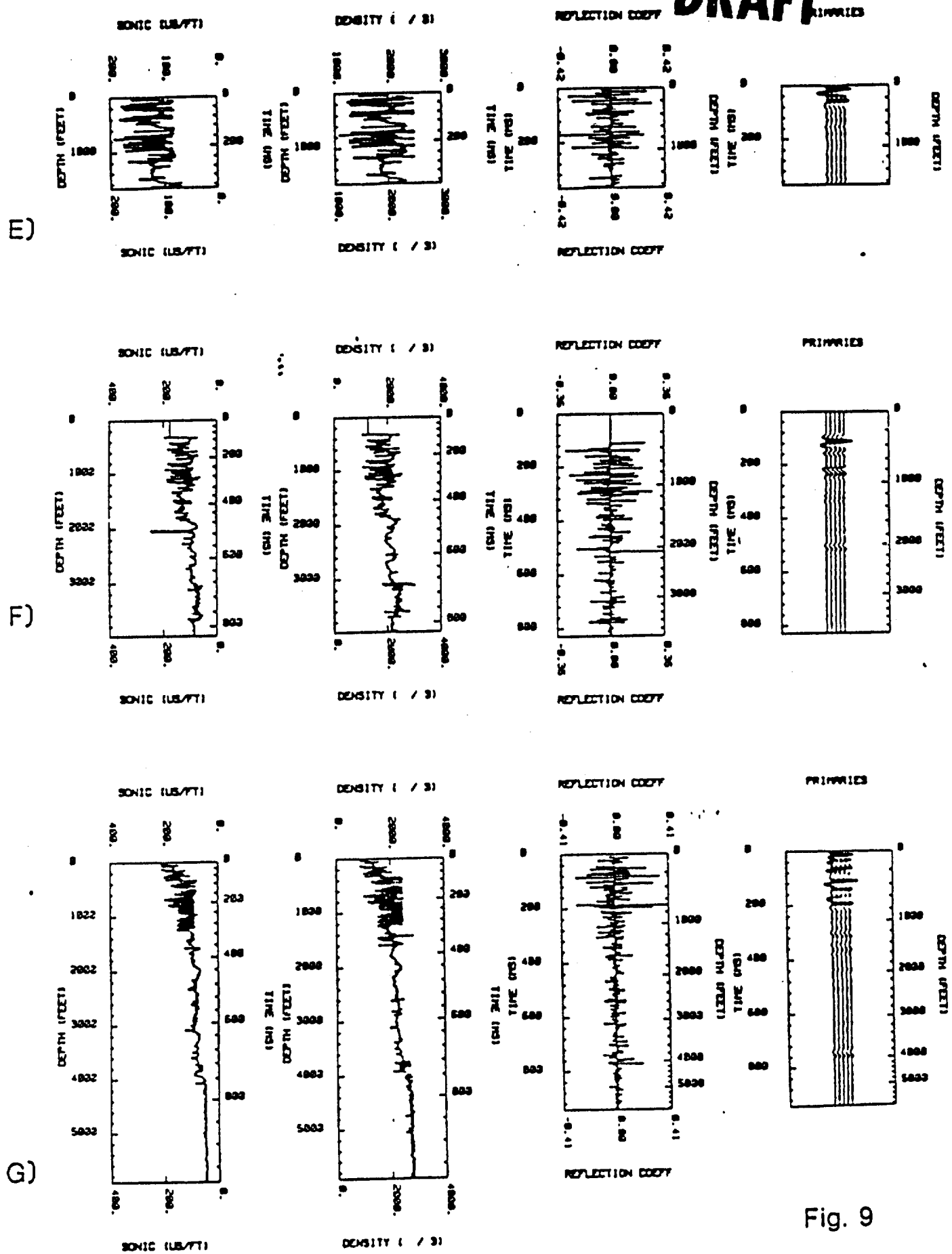

Fig. 9

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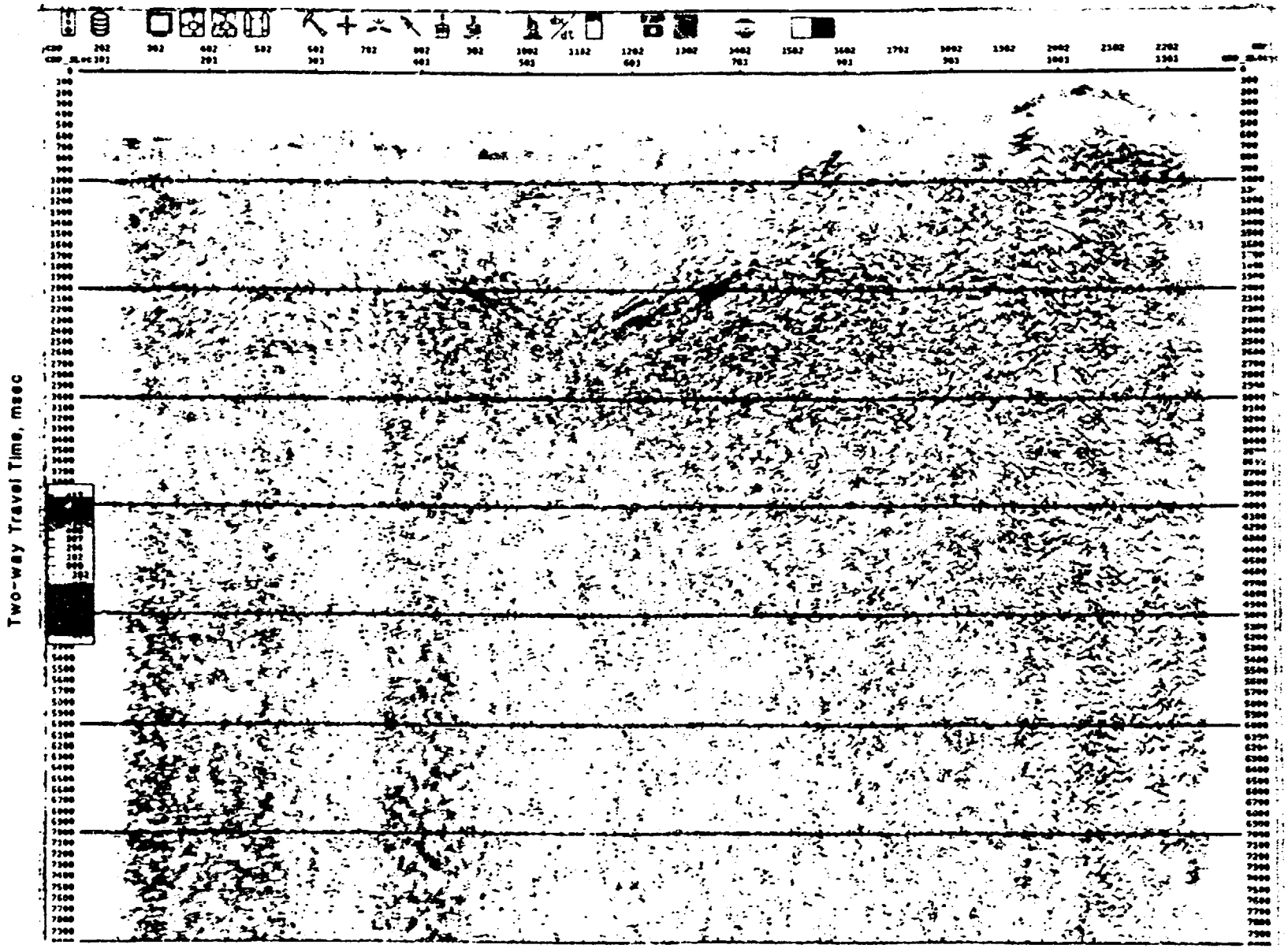

Figure 18. Uninterpreted section produced by intermediate processing of Line 2 showing section down to 8 s. This section has not been depth-converted and does not include final stacking velocities and statics. 40 stations (80 CDPs) equal one km.

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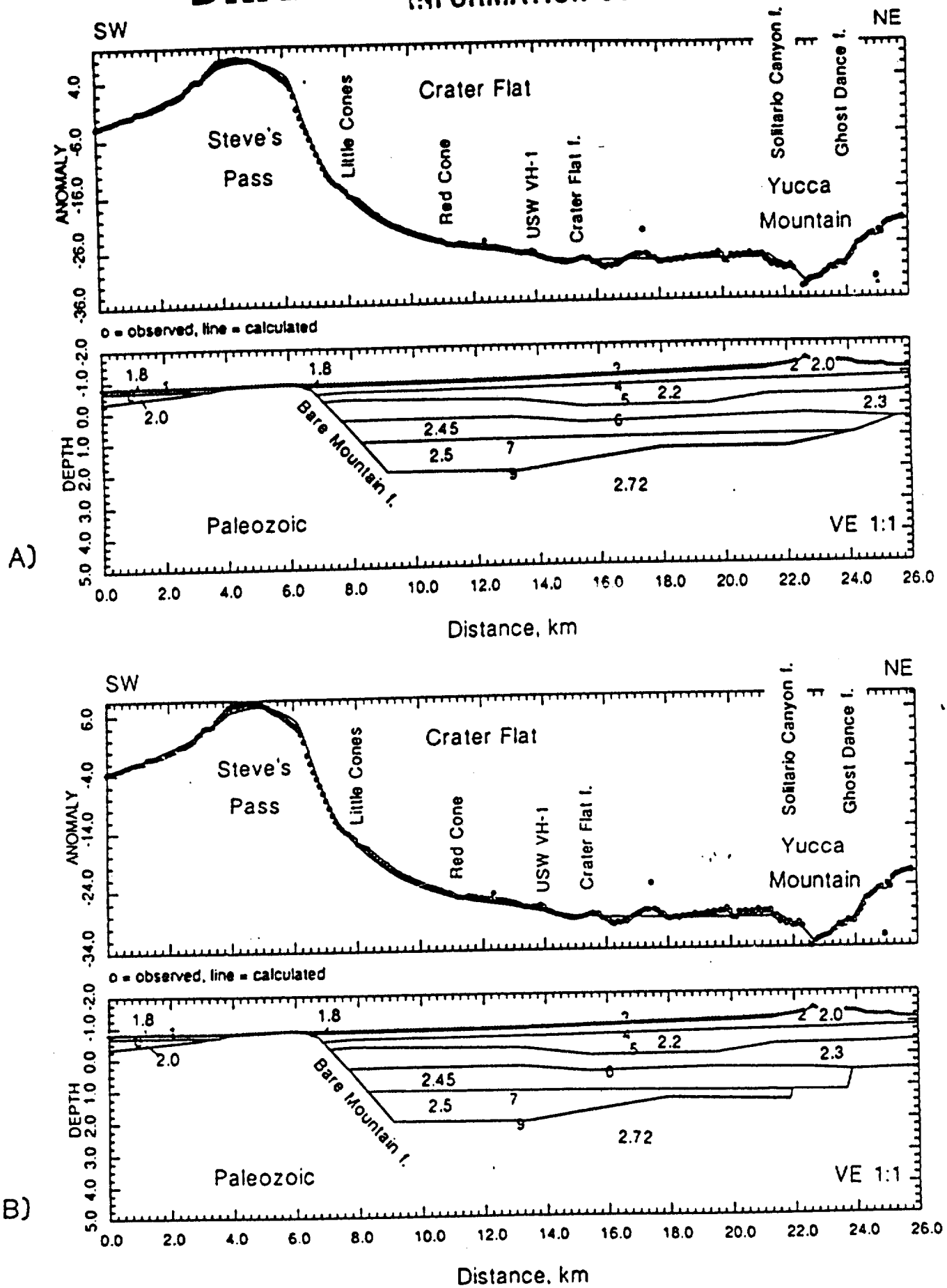

Fig. 19

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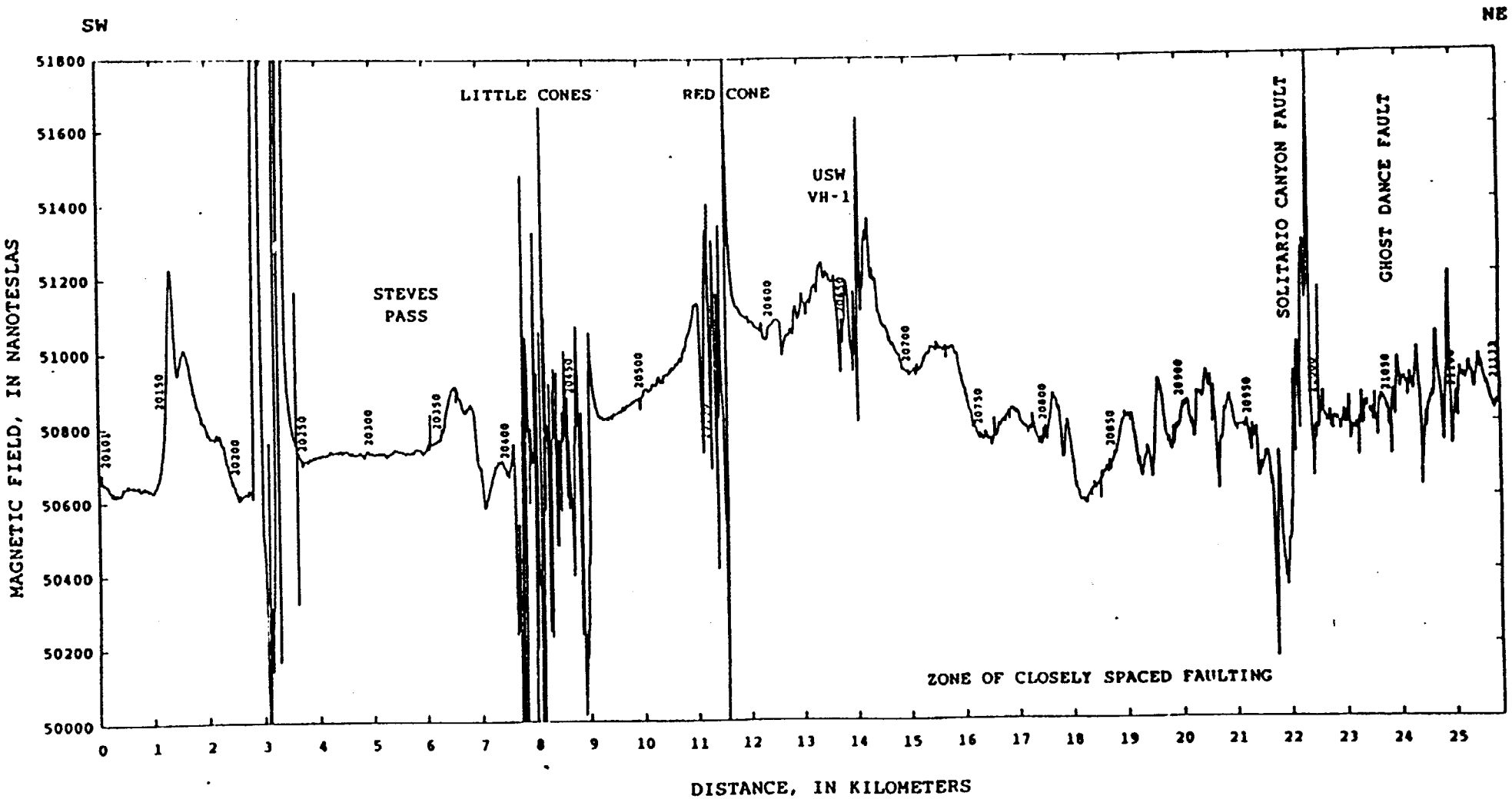

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Fig. 20

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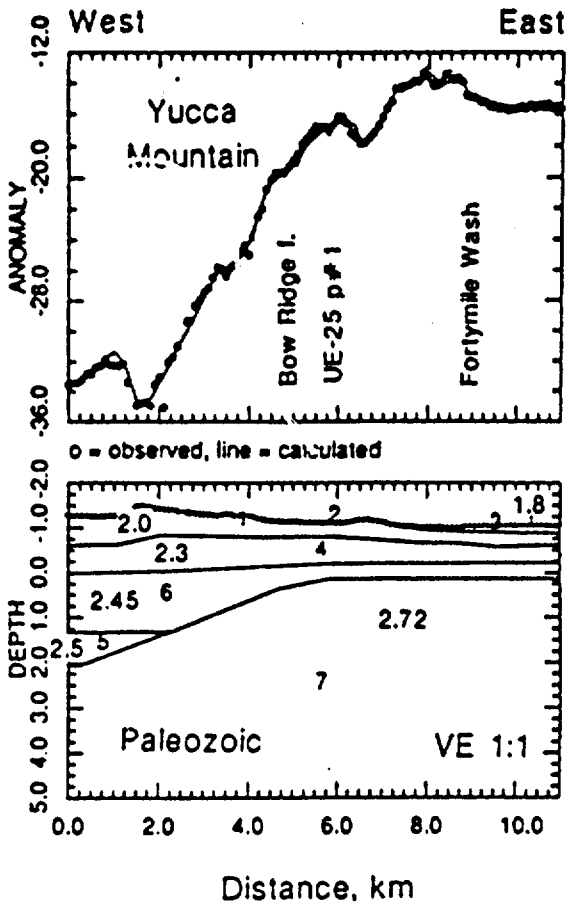
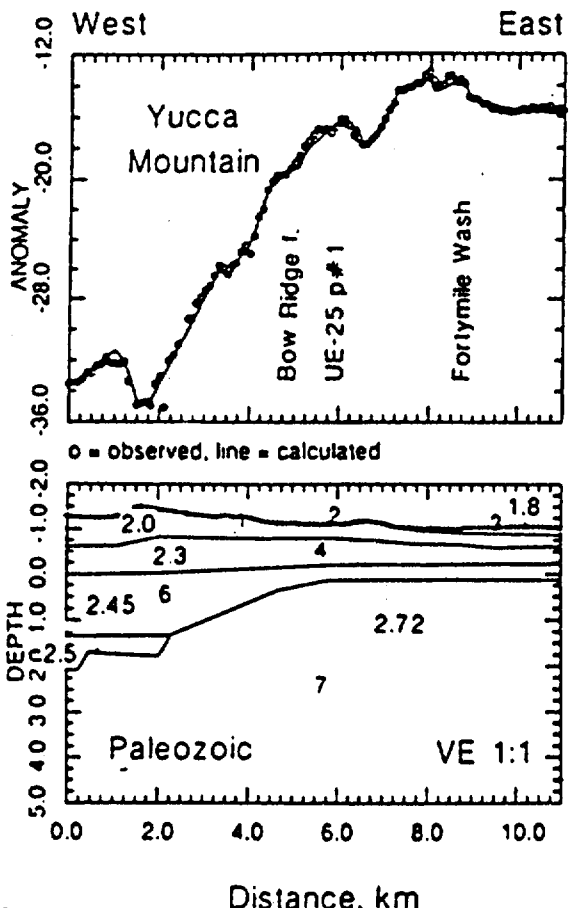


A)



B)

Fig. 21

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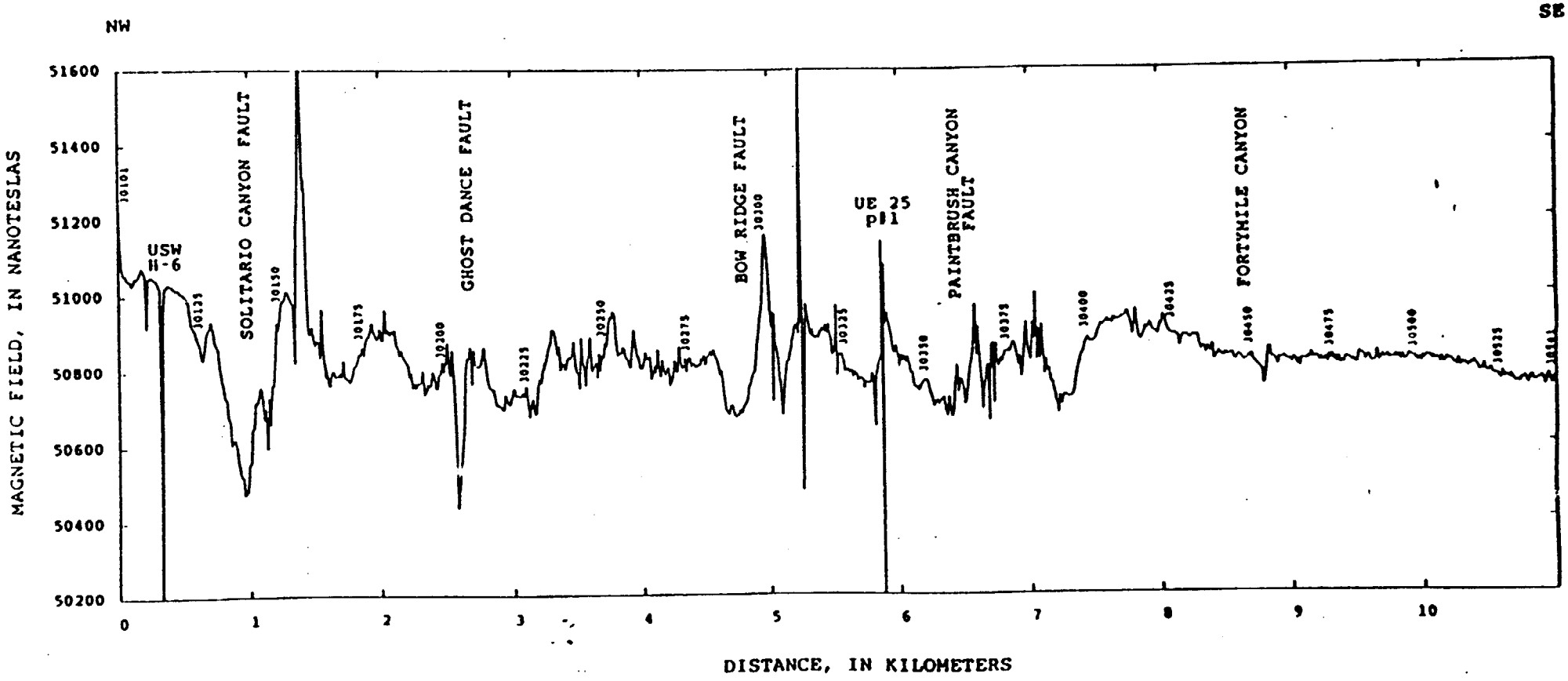

Fig. 22

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