Walkaway Seismic Experiments: Stewart Gulch, Boise, Idaho

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1.0 Summary

CGISS conducted walkaway seismic experiments for the Terteling Company that successfully recorded reflections at both the Windsock and Motorcycle test sites in Stewart Gulch near Boise, Idaho. The strongest of the reflections recorded at the Windsock site appear to be generated at the interface between the sedimentary section and underlying volcanic rocks at a depth of approximately 500 feet. Although the reflections recorded at the Motorcycle site are less dominant on the seismic records and are affected by static shifts, the strongest arrivals appear to be from the same interface between sedimentary and volcanic rocks but at shallower depth.

The data quality demonstrated in the Stewart Gulch walkaway experiments is good enough to warrant acquisition of standard CMP (common midpoint) seismic reflection profiles to map subsurface structure and stratigraphy. The recommended station spacing is 3 m with a minimum source-receiver offset of 25 m. Source efforts should be acquired at every station with a 48-channel system to produce 24-fold CMP reflection coverage. Source tests suggest that the EWG accelerated weight drop source operated at the surface is superior and more economical than a buried 1/3-lb Kinestik explosive charge.

2.0 Introduction

The Stewart Gulch walkaway seismic experiments serve to determine the feasibility and acquisition parameters for a proposed seismic reflection profile along the axis of the drainage (Figure 1). Two sites for the walkaway experiments were selected, each centered around a water well with lithologic logs compiled by E. Squires (Figures 1 and 2). The northeastern walkaway experiment is near the Terteling Motorcycle Club well which shows a sand sequence with some interbedded clays from the surface to 375 feet depth. A volcanic rock/sedimentary rock sequence is interpreted from 375 feet to the well bottom at 712 feet. Below this sequence, granite of the Idaho Batholith is interpreted based on data from nearby wells. The exact depth to the Batholith is unknown. The southwestern walkaway experiment is near the Windsock well which shows mostly clays with interbedded sands and silts to 500 feet. Below 500 feet, interbedded basalt and clays are interpreted to the base of the well at 600 feet.

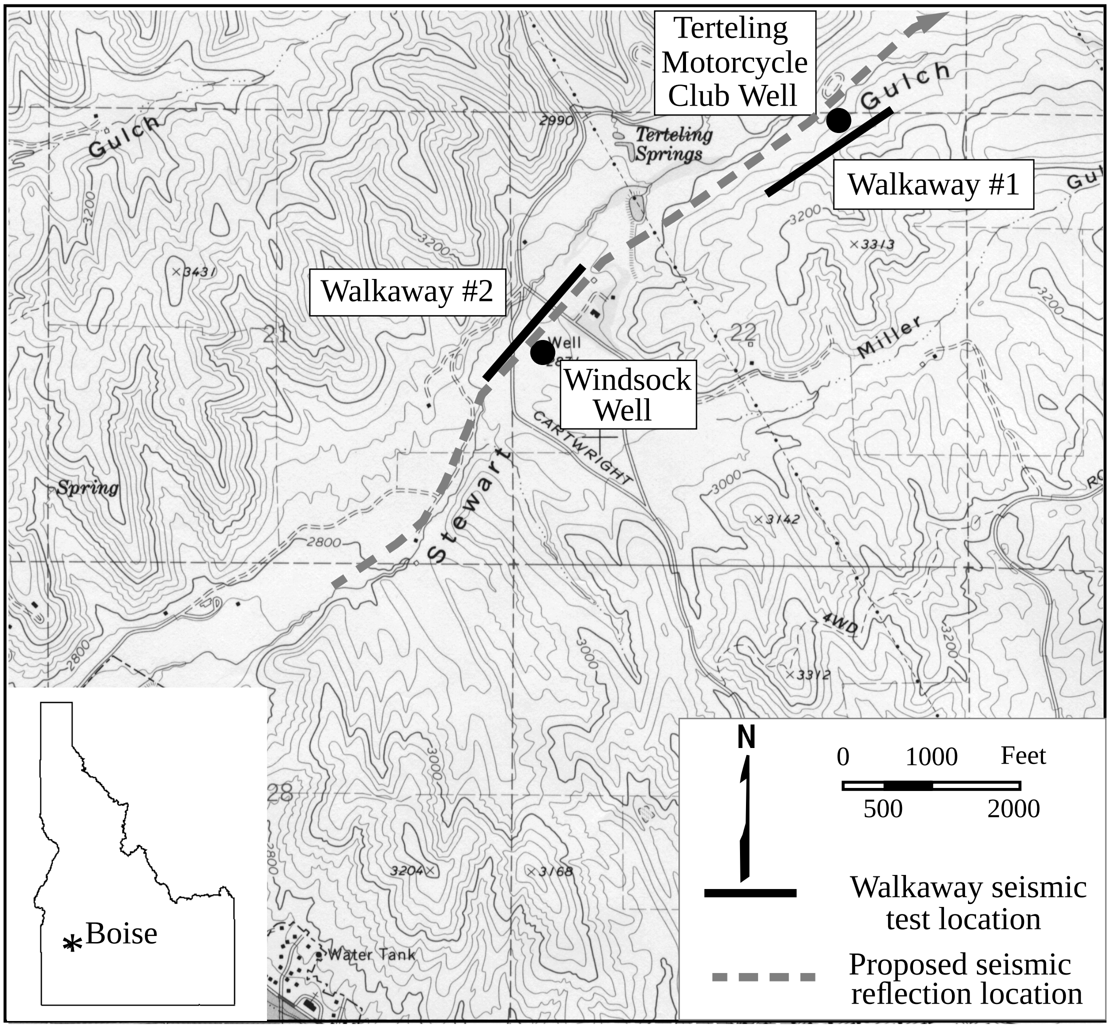

Figure 1. Topographic map of the field site northwest of downtown Boise. Walkaway locations and proposed seismic line location are shown.

A seismic walkaway experiment is an initial test to determine if seismic reflections can be recorded with various shot sources and a densely spaced spread of geophones. Recording parameters (analog filters, sample rate, recording time) are conservatively estimated to determine the optimum settings for a future seismic reflection experiment. Once the raw data are collected, post-processing of the field records can aid identification of reflections and help define the optimum station spacing, source type, size, and number of repetitions, and recording parameters for a 48-channel seismograph.

Based on the lithologic logs from wells on the site, a large amplitude reflection is expected from the interface between the sedimentary rocks and underlying sequence of volcanic rocks (because of the contrasts in velocity and density between the two rock types). Also, reflections in the upper sedimentary section are expected from contrasts between the clay and sand units, but reflection amplitudes are not expected to be as strong as those associated with the sedimentary/volcanic rock interface. Velocity measurements from a seismic

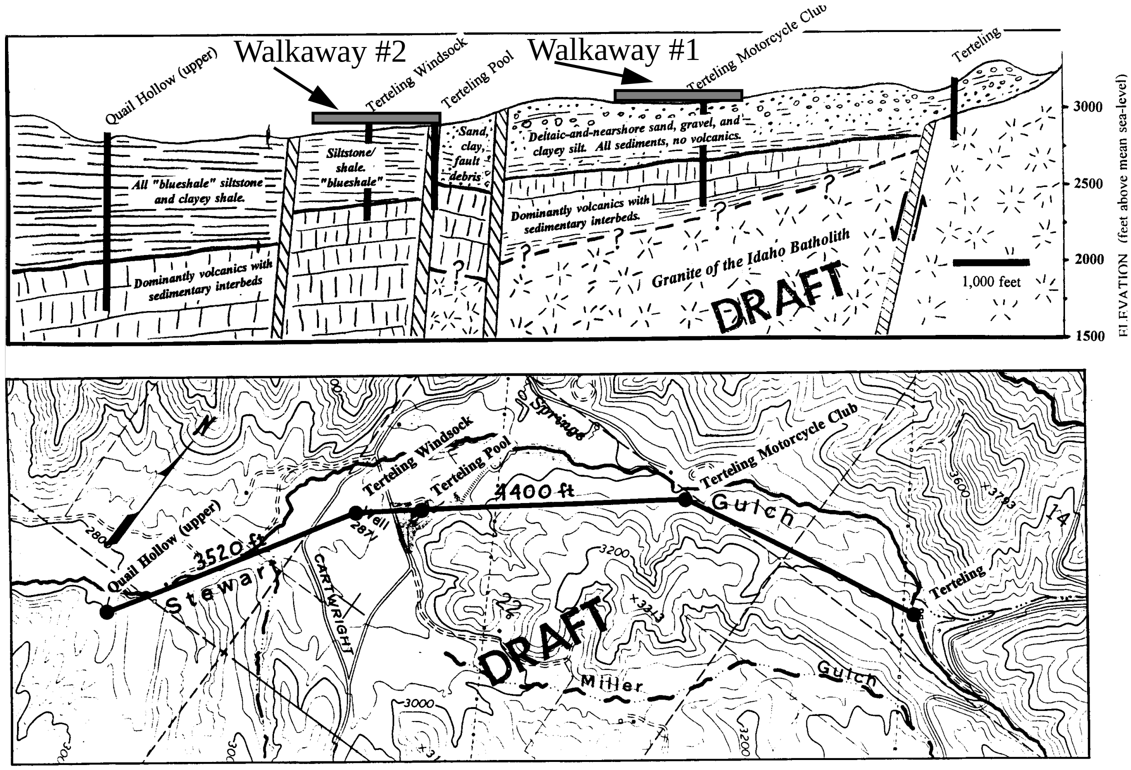

Figure 2. Geologic cross-section based on local water well information (figure from E. Squires). Walkaway locations are also noted.

walk-away experiment can only be estimated because of a lack of information regarding the geologic dip and lateral structure, but depths to the reflecting interfaces can still be inferred. A CMP seismic reflection profile would provide adequate redundant information at each subsurface position to improve the signal to noise ratio and provide accurate velocity information, thereby producing accurate depth and dip estimates along the entire profile.

3.0 Terteling Motorcycle Club Walkaway Test

3.1 Acquisition Parameters and Environment

Data from the Motorcycle Walkaway Test (Figures 1 and 2) were collected on 30 May 1996. Nine shots were recorded using 1/3-lb Kinestik explosive drilled to about 1-m depth using a 3-inch auger drill. Also, nine EWG shot locations were collected storing 1, 4 and 9 individual blows for each site to determine the optimal number of blows. A greater number of hammer blows increases the signal to noise ratio. Drilling presented few problems for placing the Kinestik charges, penetrating mostly sand and alluvium. A hard sand lens was noted in the northern shot holes. Only soil from the two southern shot holes in the alfalfa field appeared damp. A 1-m (3.28 ft.) geophone spacing, 48-m (157 ft.) shot spacing, and 240-m (787 ft.) maximum source to geophone distance allowed continuous and complete coverage for the target depths inferred from the well lithologic data (Figure 2). The shots were distributed in-line near the well, with two shots northeast of the Terteling Motorcycle well and seven shots southwest of the well. Geophones were placed from the northeast corner of the alfalfa field extending to the southwest. Geophone baseplates were used along the geophone spread with 10-20 lb sandbags placed on top to ensure adequate coupling to the field and to minimize ambient noise.

3.2 Data Recording and Processing

Field filters within the seismograph were left open (4-1000 Hz) to determine the reflection window bandwidth. Two seconds of recording at a 0.5-ms sampling rate allowed adequate time and sampling for the target depths and source energy type. Processing included combining each 48-channel record into a continuous gather, followed by application of a spectral shaping filter and amplitude gain. A spectral analysis from the seismic reflection "optimum window" shows most signal energy in the bandwidth from 70-200 Hz. Lower frequency coherent noise appeared in the reflection window caused by waveguide reverberations from near surface contrasts, but this energy was greatly attenuated with the shaping filter. The gain window was designed to optimize the reflection signal.

3.3 Interpretation

Walkaway results at the Motorcycle site using the 9-stack EWG source (Figure 3) show a clear reflection at 150-ms zero-offset two-way travel time. The estimated RMS velocity (~1,500 m/s) and the observed travel time (150 ms) are consistent with a reflection from the interpreted upper basalt unit identified in the Terteling Motorcycle well (370-ft. depth). The reflection appears time-shifted away from the expected smooth hyperbolic shape, but the time shifting is also present in the head wave arrivals and suggests topography in the near-surface layers. Reflections in the upper sedimentary section may be present but are difficult to interpret without adequate near-surface static corrections. A weak arrival appears in the walkaway with a zero-offset two-way travel time of approximately 210 ms. This arrival, which is much stronger and confirmed on the Kinestik data (not shown in this report), may be a reflection from the upper surface of the Idaho Batholith. Although the reflector possibly associated with the Batholith may be imaged more clearly with the Kinestik source because of the larger amplitude signature, it is considered a secondary target.

4.0 Windsock Walkaway Test

4.1 Acquisition Parameters and Environment

Data for the Windsock Walkaway Experiment (Figures 1 and 2) were collected on 31 May 1996. Ten source locations were recorded using 1/3-lb Kinestik explosive drilled to about 1-m depth and with the EWG accelerated weight drop source (as before, EWG shot locations were collected storing 1, 4 and 9 individual blows for each location). Excellent conditions for both sources and the receivers were realized due to the relative proximity of a

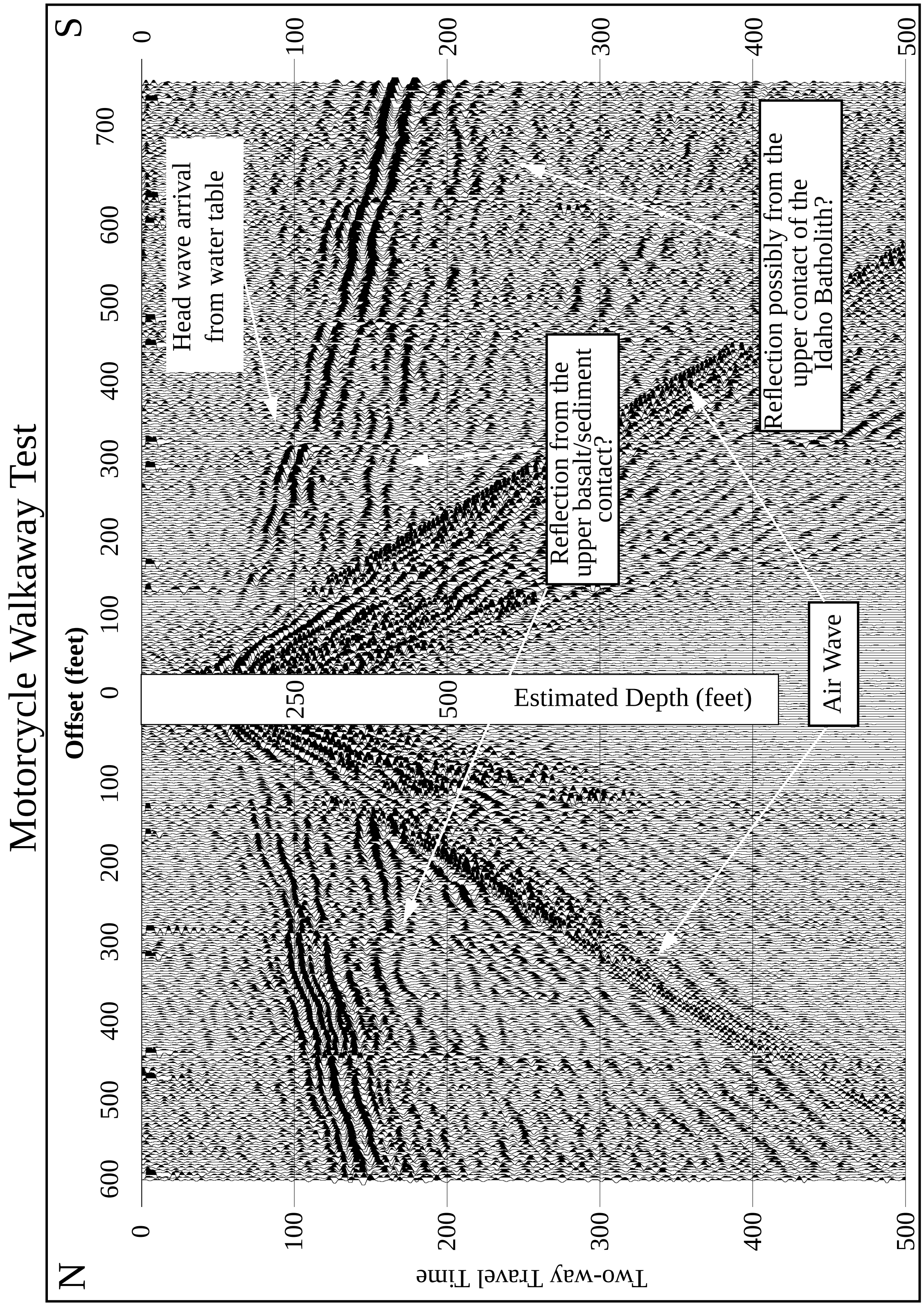

Figure 3. EWG walkaway results from the Motorcycle walkaway test. Note the reflection interpreted from the upper basalt contact and the weaker reflection deeper in the section possibly from the upper contact of the Idaho Batholith. Additional reflections in the upper section may also be present, but difficult to image due to the recording environment.

stream and from the flat topography and tilled fields. A 1-m geophone spacing, 48-m shot spacing and maximum source to far receiver offset of 240 m (787 ft.) provided the needed coverage for the maximum expected target depth. The 48 geophones straddled the Windsock well with a well to seismic line perpendicular offset of approximately 210 ft. The soil from the drill holes was damp in most holes.

4.2 Data Recording and Processing

Acquisition parameters were identical to the Motorcycle walkaway test. A spectral shaping filter from 70-200 Hz was applied to the EWG 9-stack raw data and displayed (Figure 4) with a reflection window gain to highlight the reflection package. The Kinestik results (not shown in this report) are similar to the EWG gather, but with poorer signal quality in the upper section.

4.3 Interpretation

An energetic reflection package appears on the Windsock walkaway test from 190 to 210 ms zero-offset two-way travel time. These arrivals are hyperbolic in shape, as expected for a reflection, and are in the window of expected reflections for the volcanic rock/sedimentary rock interface. The estimated RMS velocity of the reflected arrivals is approximately 1500 m/s. This puts the depth to the upper contact of the volcanic/sedimentary units at approximately 140 m (460 ft.) and is consistent with the lithologic log of the Windsock well. Other lower amplitude reflection arrivals also appear above the 190-ms time window and are most likely associated with the clay/sand interbeds interpreted from the lithologic log.

5.0 Discussion

The results of the walkaway experiments from the Windsock and Motorcycle sites indicate that Stewart Gulch is a favorable setting for seismic reflection profiling using multiple hammer blows with the EWG accelerated weight drop source. The reflections discussed above are consistent with the geologic units interpreted by Ed Squires from water wells in the region. Also, the reflection character appears to change from the dominantly clay sequence to the southwest to the sandy sequence to the northeast. The walkaways suggest that this lateral contrast in sediments can be seismically imaged. Based on experience gained with other seismic reflection studies from the Boise Valley, and the strong reflections seen from the upper contact of the basalt unit, imaging faults in the region should be possible. This suggests a seismic reflection profile would assist in better defining the hydrogeologic character of the Stewart Gulch region.

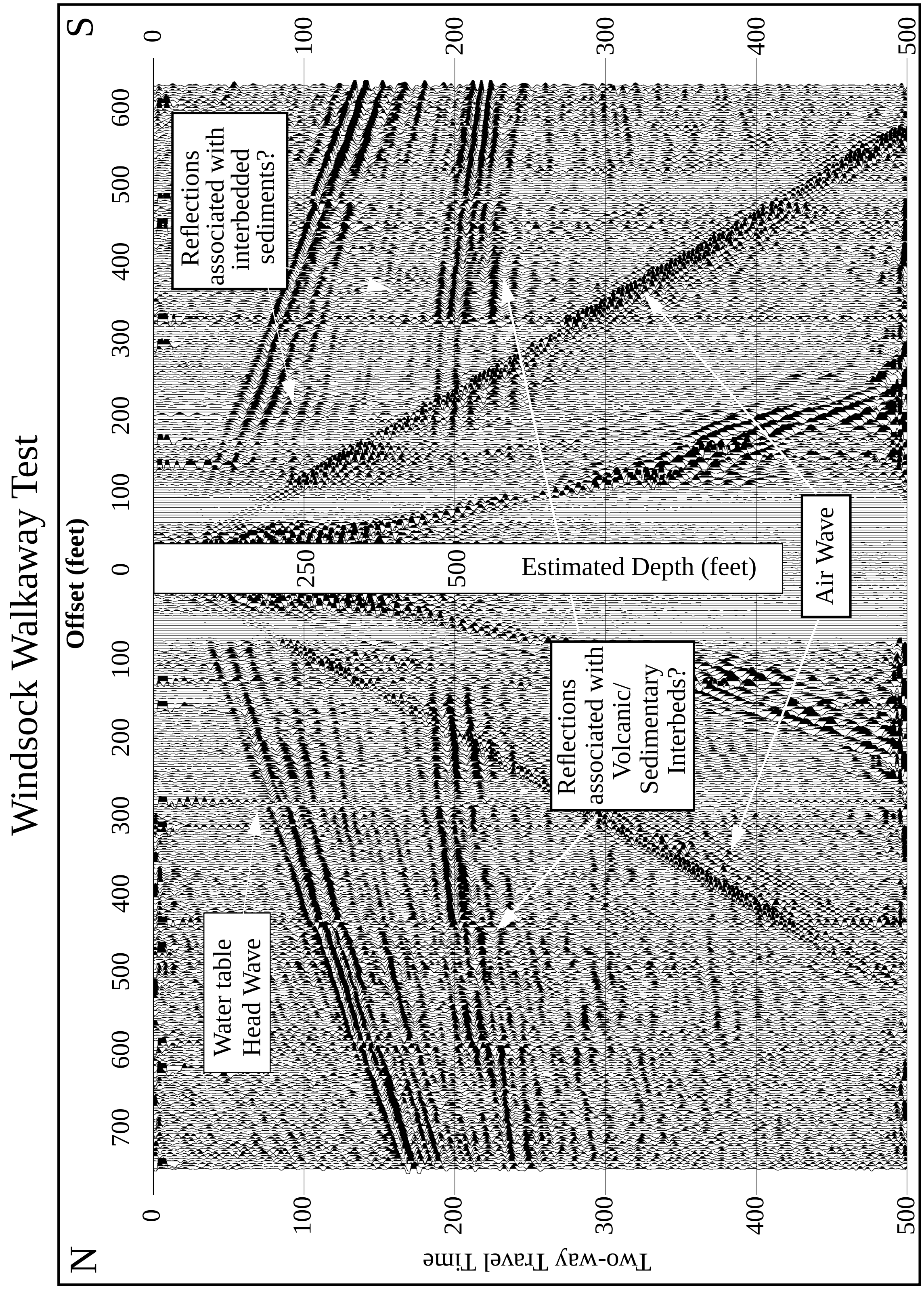

Figure 4. EWG walkaway results from the Windsock well location. The high quality of the walkaway results from the saturated near-surface conditions, minor topography and uniform lateral geology.

6.0 Acknowledgments

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