50 MHz GROUND - PENETRATING RADAR GEOPHYSICAL PROFILING FOR DEPTH TO BEDROCK AND SEDIMENT THICKNESS AT THE YORK CREEK DAM, ST. HELENA, CALIFORNIA

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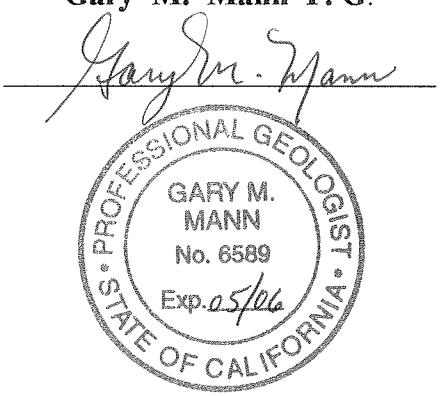

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Earth Imaging Geologic Services is pleased to present Blackburn Consulting, Inc. with the following geophysical report and profiles for the York Creek Dam project area. The project site is situated along Spring Mountain Road a few miles west of St. Helena, California. An extensive, 50 MHz, ground-penetrating radar (GPR) survey was conducted within the accessible portions of the upstream impoundment area on October 26, 2005 and was successful in completing the project objectives as described below.

Objectives of Geophysical Investigations

The scope of this investigation involves a program of subsurface geophysical imaging with 50 MHz GPR for the purpose of identifying the estimated depth to bedrock and corresponding, overburden sediment thickness, within accessible parts of the York Creek Dam impoundment basin. The basin-longitudinal GPR profiles (profiles1, 2 and 3) extended approximately 420 feet northwesterly, upstream of the dam area, from a point located roughly 60 feet from the base of the east (Spring Mtn. Rd. side) abutment. Three, approximately east-to-west trending, crossing profiles, ranging from 53 to 89 feet in length (profiles 4, 5 and 6) were also acquired to better control subsurface basin geometry. The start and end locations for the 6, separate, 50 MHz GPR profile transects were marked with wooden stakes and labeled accordingly at the site for future survey location on an upgraded site topographic base map.

The primary objective of this geophysical survey is to provide subsurface basin geometric control to assist in a volumetric estimate of the sediment overburden within the impoundment area. The locations of the top of the bedrock interface are annotated on the respective GPR geophysical profiles with yellow highlighting. Estimated depth to the top of the bedrock interface, typically at profile start and end points and the deeper center points, are labeled on the respective radargrams. The approximate error for the geophysical profile assessment of the estimated bedrock depth should be about $\pm$10%.

The individual GPR geophysical profiles are housed in three notebook comprising the "Geophysical Appendix" which also contains the unbound report of findings. The sediment overburden, primarily consisting of sands, silts and gravels, are labeled on the profiles as "sediments". The inferred bedrock below the yellow highlighted, bedrock-sediment interface, is labeled as "bedrock". The yellow highlighted bedrock-sediment interface is typically inferred to be the top of the firm bedrock under saturated ground water conditions at this site. A weathered zone of rock may lie at a somewhat shallower depth, as well as brecciated or severely fractured rock, as low frequently GPR frequently images these lithologic occurrences more similarly as soil or alluvial deposits.

Geophysical Method of Investigation - Acquisition, Processing and Scalar Parameters

The method of geophysical subsurface *imaging* utilized for this investigation is ground-penetrating radar (GPR). GPR is a reflection geophysical method that uses electromagnetic waves in the radio frequency range that are transmitted into the ground and bounce back as reflections from geologic interfaces such as soil boundaries, underflow channels and bedrock interfaces. These reflections are collected as single traces collected over a sample or "shot" and digitally stored in a lap top computer. The GPR transmitter and receiver are then moved (0.1 foot or approximately 1.2 inches in this survey) to a new sample area and another trace is collected. Hundreds of these traces are consecutively collected and displayed together to form a ***profile*** or line, which is essentially a vertical slice view of the geology and buried objects under the GPR ***transect***.

For this sediment overburden and bedrock interface geophysical survey the GPR profiles were collected with 50 MHz, low-frequency antennas typically utilized for deeper geologic imaging requirements up to 65 feet in depth. The GPR unit is a Swedish made Mala GeoSciences product with digital data collection. The digital format allows for computer, data post-processing which greatly enhances the resolution and geometric correction of the raw data. Mala GroundVision GPR image processing software was used and standard filters such as DC filters, mean trace deletion, low pass filtering, trace averaging, and linear/exponential/auto gain settings were applied to the raw data.

The GPR images are scaled horizontally (at bottom and top) and vertically (right side) in feet. The horizontal scales record the cumulative distance from the origin (left side of profiles) along the radar transect, while the vertical scale records the estimated depth of the sediment-bedrock interface. The 42 foot vertical or depth scale for the GPR images was acquired in a 347 nanosecond time window utilizing an *estimated* electromagnetic wave velocity of 245 feet/microsecond. This em velocity estimate was calculated with a firm, end-member velocity of 195 feet/ms in fully saturated soils (below water table) and a typical velocity for moist, unsaturated, sandy soils of 335 feet/ms. The *estimated* depth to the top of the saturated zone is about 10 feet for most of the survey area. Because the typical or average depth to bedrock for the profiles is in the 20-29 foot depth range, the em velocity is skewed at a ratio of approximately 2:1 towards the saturated media velocity (195 feet/ms) The estimated depth of the sediment/bedrock interface should have an error range of approximately $\pm$ 10%. The resulting vertical exaggeration for the 50 MHz profiles is about 1.1: 1, or very close to true scale.

50 MHz Ground-Penetrating Radar Geophysical Survey Findings

GPR profile 1 was acquired along a southeast-to-northwest transect which mostly, obliquely, bisects the lower (southern) accessible part of the York Creek drainage. Profile 1 is the southernmost of three, contiguous, basin-longitudinal GPR profiles (profiles1, 2 and 3) which extends approximately 420 feet northwesterly, upstream of the dam area. Profile 1 starts along the east edge of the existing dirt access road, roughly located at a point 60 feet from the base of the east (Spring Mtn. Rd. side) dam abutment. The maximum estimated depth of the bedrock-sediment interface is

29 feet at horizontal position 48 feet and a similar depth occurs at horizontal position 31 feet. The estimated bedrock-sediment interface depth at the southeast origin of profile 1 is about 24 feet. At the northwest terminus of profile 1 the estimated bedrock-sediment interface depth has shallowed to 21 feet (near horizontal position 100 feet).

GPR profile 2 starts at the terminus of profile 1 which is located approximately 8 feet from a blackberry thicket, which is roughly 25 feet from the base of the topographically steep, west creek bank. Profiles 2 and 3 are reasonably close to south-to-north in orientation so these approximate orientations appear on these profiles. A matching depth (from profile 1 terminus) of 21 feet to the bedrock-sediment interface is imaged at the south profile 2 origin. A maximum estimated depth of 28.5 feet occurs at horizontal position 46 feet on profile 2. Because profile 2 is 143 feet long it is displayed on two separate pages in the geophysical appendix. At horizontal position 84 feet at the page break a depth of 25 feet is estimated to the bedrock-sediment interface. At the northern terminus of profile 2 the estimated depth to the bedrock interface has remained nearly flat at about 24.5 feet.

GPR profile 3 is the longest profile at 179 feet, is displayed on two pages and terminates in the northernmost accessible reaches of the York Creek Dam impoundment basin. The first 50 feet of profile 3 has a consistent estimated depth to the bedrock-sediment interface of 25 feet. A very slight shallowing to 24 feet appears to occur between horizontal position 70 to 105 feet. This part of the profile contains some air-wave overprint such that the actual depth to the interface may be a foot or two deeper. Air-waves are caused by that part of the electromagnetic wave front which propagates upward, reflecting back down off tall, immediately adjacent objects, in this case redwood trees and is recorded as an "arrival" by the receiver. Air-wave interference overprint diminishes approximately at horizontal position 120 feet and a good bedrock-sediment interface is imaged for the remaining 60 feet of profile 3. The bedrock-sediment interface steadily climbs from 25 feet deep at horizontal position 120 feet to about 17-18 feet deep at the north profile terminus. The York Creek drainage begins to constrict in width rapidly near the profile 3 terminus.

Three, approximately east-to-west trending, crossing profiles, ranging from 53 to 89 feet in length (profiles 4, 5 and 6) were also acquired to better control subsurface basin geometry. These profiles are oriented approximately perpendicular to the contiguous profile1-3 composite transect. Profile 4 crosses profile 3 roughly 50 feet north of the profile 2-3 terminus/origin point. Profile 4 is 53 feet long and has an origin to the northeast (Spring Mtn. Rd. side) located about 10 feet from the existing creek. The profile 4, northeast origin has an estimated depth of 24 feet to the bedrock-sediment interface. The deepest area is at horizontal position 22 feet where the estimated interface depth is 25 feet. The southwest terminus of profile 4 has an estimated bedrock-sediment interface depth of 22.5 feet. The terminus of profile 4 is about 4 feet northeast of a large fallen redwood trunk which prevented an additional acquisition of roughly 15-20 feet to the base of the steep southwest hillside.

GPR profile 5 passes through the profile 2-3 terminus/origin common point and is perpendicular to those profiles along a northeast-to-southwest orientation. Profile 5 starts to the

northeast about 5 feet from the existing creek and extends southwest nearly to the base of the steep southwest hillside, falling little more than 10 feet short. Therefore profile 5 is quite valuable in estimating the steepness of the southwest hillside, subsurface bedrock-sediment interface. To the northwest near the existing creek the estimated depth to the bedrock-soil interface is 20 feet. The deepest area on profile 5 is at horizontal position 33.5 feet where a depth of 25 feet to the bedrock-sediment interface is imaged. At approximately horizontal position 55 feet the bedrock-sediment interface rises with a more significant gradient, reaching a shallow depth to bedrock of only about 13.5 feet. The sub-spherical or beaded nature of the top of the bedrock reflection along the last 10 feet of profile is consistent with boulders or coarse shale talus and these materials may reach a more conservative depth of about 12 feet at the profile 5 terminus.

GPR profile 6 is 82 feet long and is oriented along a northeast-to-southwest transect with a northeast origin point located 4 feet from the existing creek. Profile 6 crosses profile 2 very roughly near horizontal position 40 feet on profile 2. The northeast origin of profile 6 has a well imaged depth to the bedrock-soil interface of about 23 feet. The deepest part of profile 6 lies at horizontal position 26.5 feet with an estimated depth to the bedrock-sediment interface of 28 feet. The bedrock interface rises somewhat abruptly near horizontal position 45-48 feet, where the interface forms a bench-like feature, about 22 feet deep to bedrock, for a distance of about 20 feet. The shallowest part of profile 6 lies at the southwest terminus where an estimated depth to firm bedrock is about 18 feet. There is some suggestion of a more shallow weathered bedrock zone near the southwest terminus that may be closer to 15 feet deep, however local air-wave overprint partially obscures this interface position in this area.

Conclusions

The primary objective of this geophysical survey is to provide subsurface basin geometric control to assist in a volumetric estimate of the sediment overburden within the York Creek Dam impoundment area. Impoundment basin longitudinal GPR profiles (profiles1, 2 and 3) extend approximately 420 feet northwesterly, upstream of the dams stand pipe outlet area. Three, approximately east-to-west trending, crossing profiles, ranging from 53 to 89 feet in length (profiles 4, 5 and 6) were also acquired along transects perpendicular to the profile1-3 group to better control subsurface basin geometry. The GPR profiles are good to very good in quality and elucidate the bedrock-sediment interface with clarity.

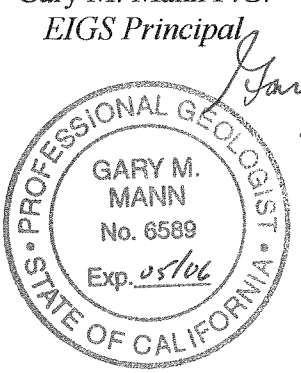
The deepest part of the bedrock-sediment interface is estimated to be 29 feet. Approximately 75-80% of the profile transect coverage images the bedrock-sediment interface at a fairly narrow depth range between 29-22 feet. Significant shallowing of the bedrock-sediment interface only begins to occur at the last 35 feet of the northern terminus portion of the survey area on profile 3, between horizontal positions 145-180 feet, where the interface is imaged respectively from 22-18 feet deep. Access along the east side of the impoundment basin lies a significant distance from the base of the Spring Mountain Road embankment, restricted to the edge of the existing creek and blackberry thickets, such that basin geometry is not well constrained in that direction. However, the northeast origin of profile 5 does show a well imaged shallowing of the bedrock-sediment interface at 20 feet in depth.

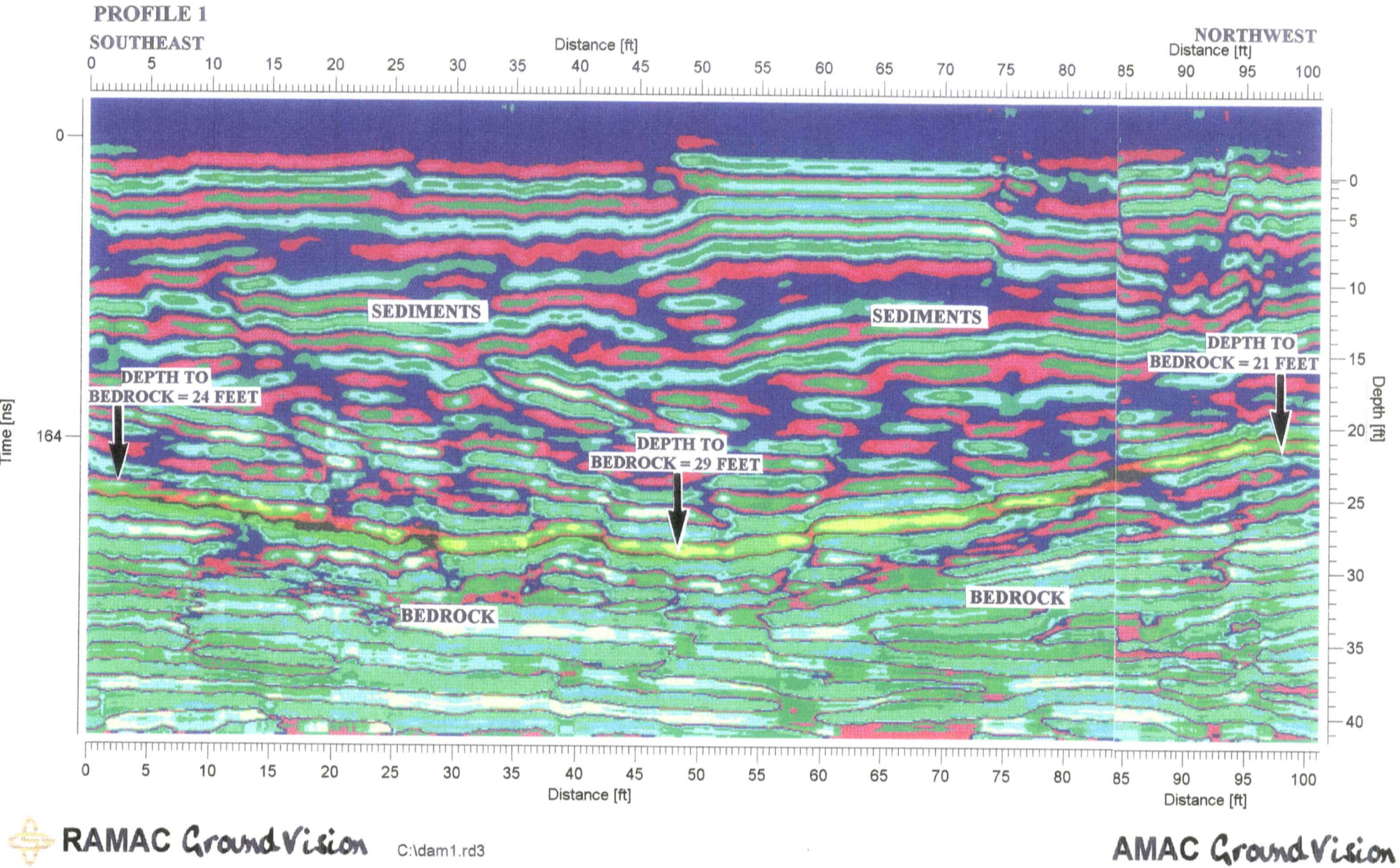
The west, or southwest edge of the impoundment basin near the steep base of the shale hillside is better constrained by the geophysical survey. At approximately horizontal position 55 feet the bedrock-sediment interface rises with a more significant gradient, reaching a shallow depth to bedrock of only about 13.5 feet at horizontal position 89 feet. The sub-spherical or beaded nature of the top of the bedrock reflectors along the last 10 feet of profile is consistent with boulders or coarse shale talus and these materials may reach a more conservative depth of about 12 feet. Profile 6 shows a similar, although less dramatic shallowing to 18 feet to the bedrock-sediment interface which lies about 15 feet from the base of the steep hillside. There is some suggestion of a more shallow, weathered bedrock zone, near the southwest terminus that may be closer to 15 feet deep.

In general, the results of this 50 MHz ground-penetrating radar survey indicates that the subsurface geometry of the sediments within the York Creek Dam impoundment basin is consistent with a U-shaped, in-filled drainage, with a steep southwest side. Below the dam, a distinct, notched, V-shaped and much deeper drainage topography exists. This suggests that the dam was constructed at a geologic constriction point along York Creek where the original topography of the drainage dropped abruptly, perhaps largely due to deeper incision into the bedrock. The generally flat bedrock floor of the bedrock-sediment interface within the impoundment basin may also, partially, be the result of modification from periodic mechanical excavation and removal of sediments and even weathered and fractured shallow bedrock.

Earth Imaging Geologic Services is pleased to have had the opportunity to assist Blackburn Consulting, Inc. with this geophysical survey for estimated depth to bedrock and corresponding sediment overburden thickness for the York Creek Dam impoundment basin. Please feel free to contact the undersigned geologist at 530.295.9272 (office) or 530.306.8040 (cell) at any time with any questions concerning the geophysical profiles or the findings contained within this report.

Sincerely,
Gary M. Mann P.G.
EIGS Principal





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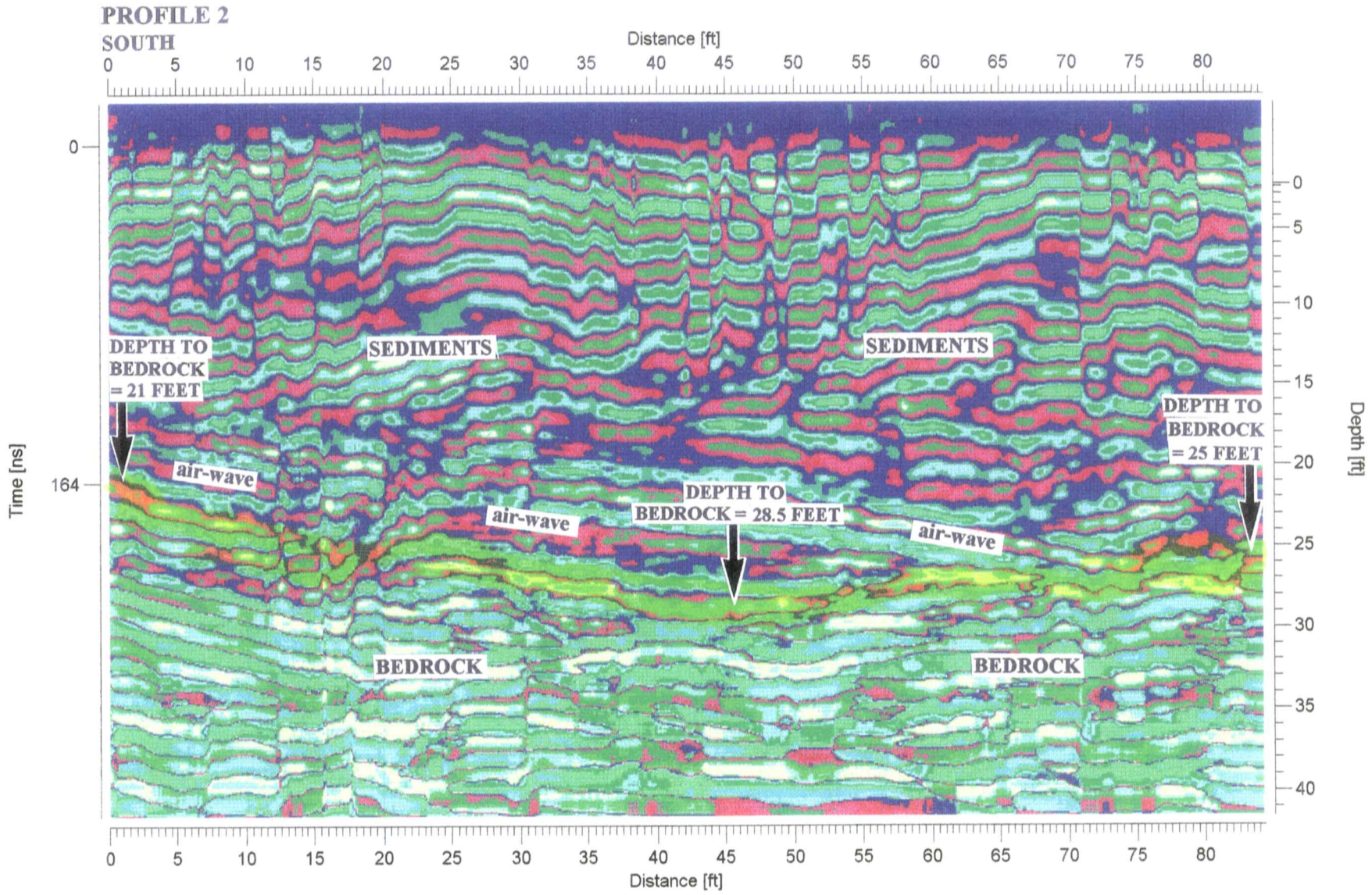
AMAC GroundVision



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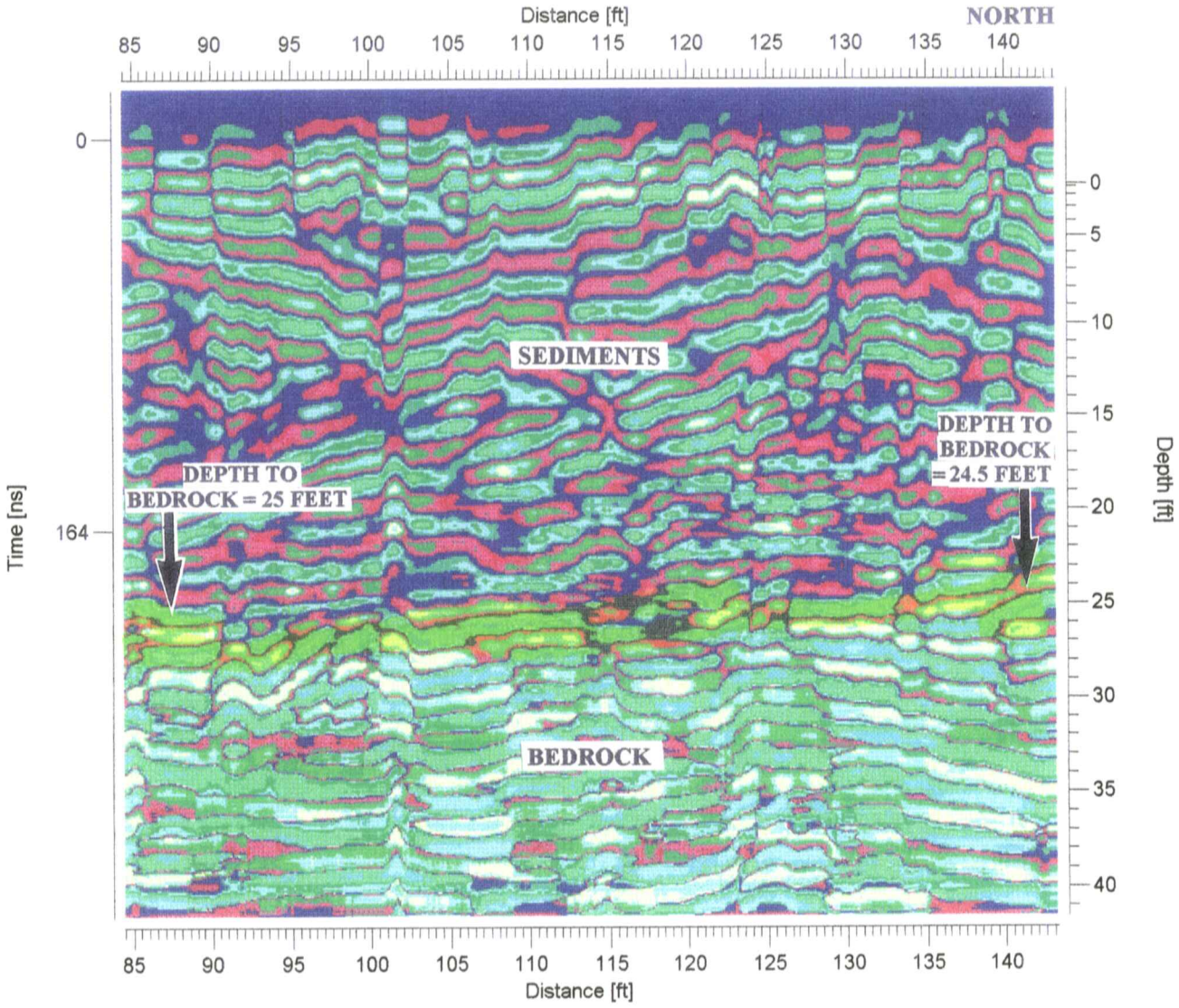
PROFILE 2 (CONTINUED)



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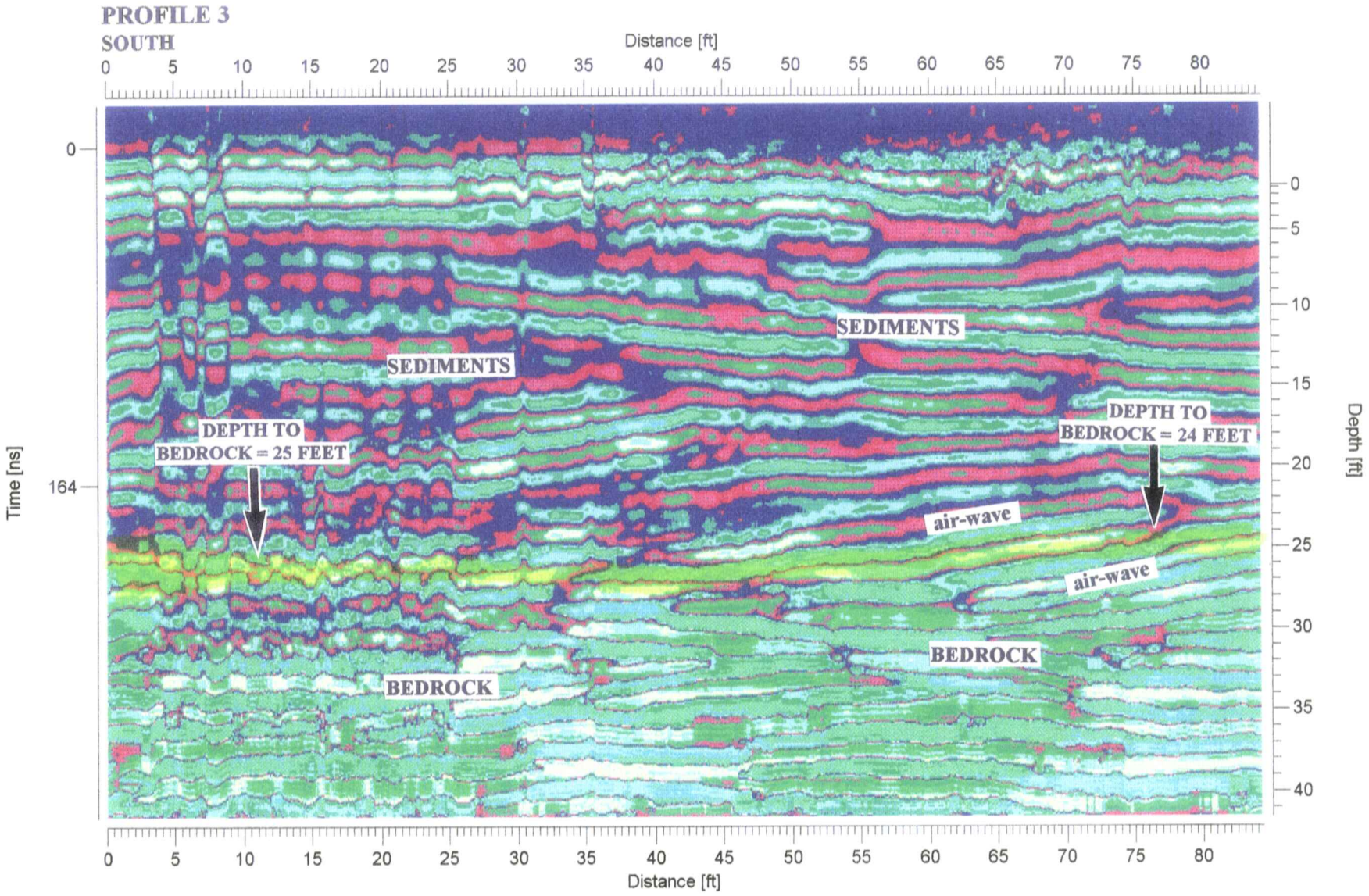

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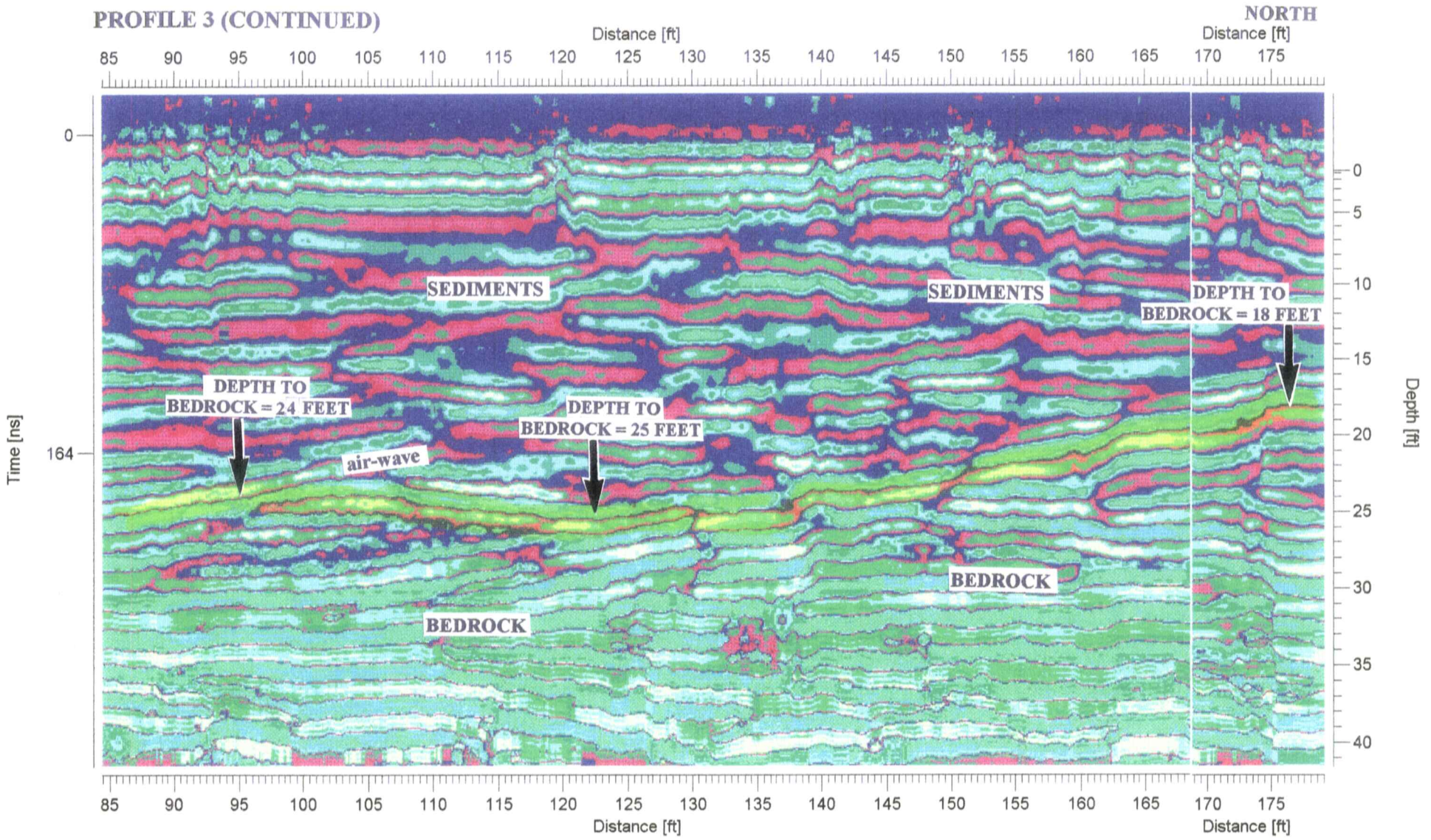
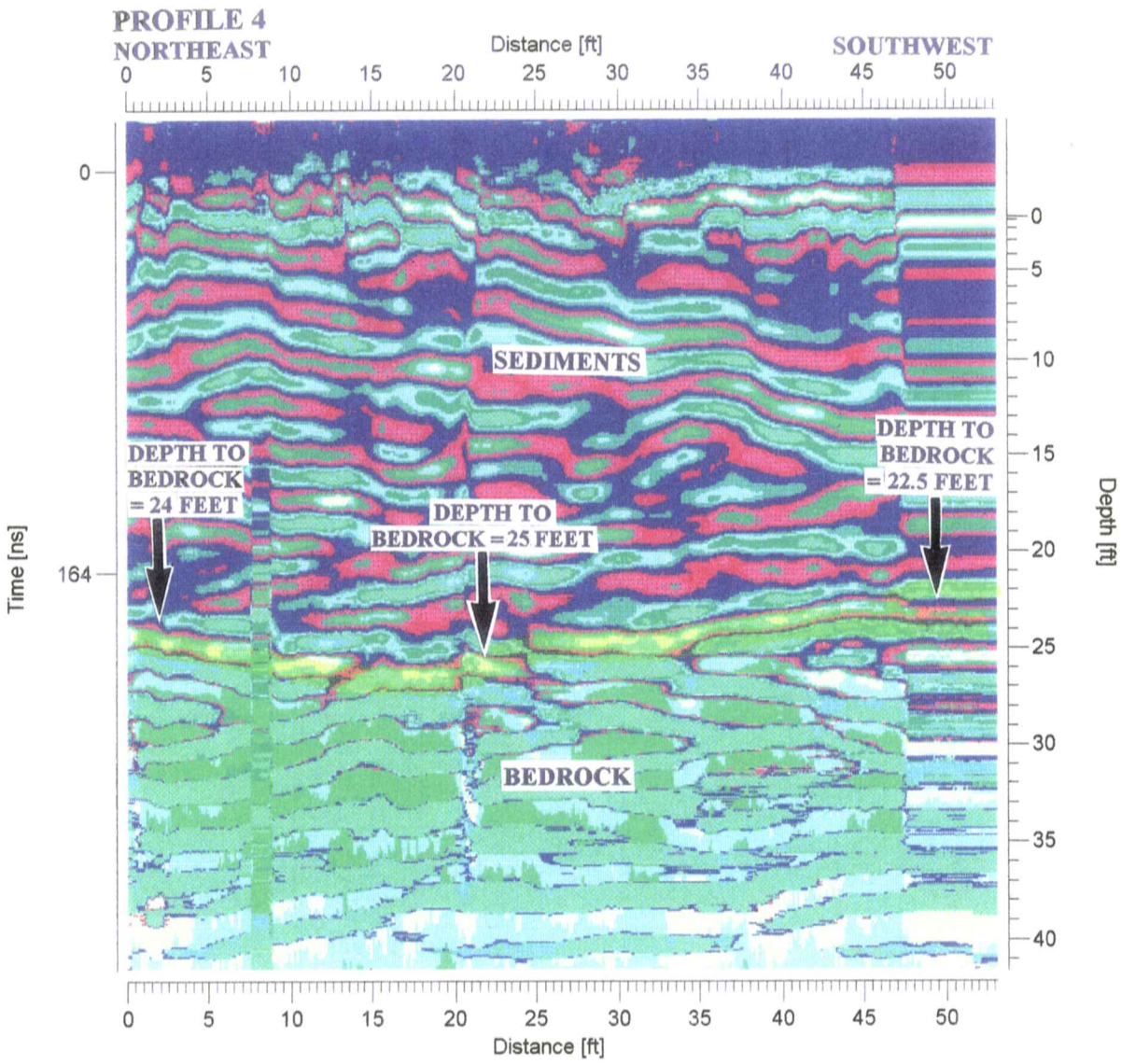

PROFILE 3 (CONTINUED)
NORTH
Distance [ft]
85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175
0
164
Time [ns]
SEDIMENTS
SEDIMENTS
DEPTH TO BEDROCK = 18 FEET
DEPTH TO BEDROCK = 24 FEET
DEPTH TO BEDROCK = 25 FEET
air-wave
BEDROCK
BEDROCK
0 5 10 15 20 25 30 35 40
Depth [ft]
RAMAC GroundVision
C:\dam3.rd3
AMAC GroundVi



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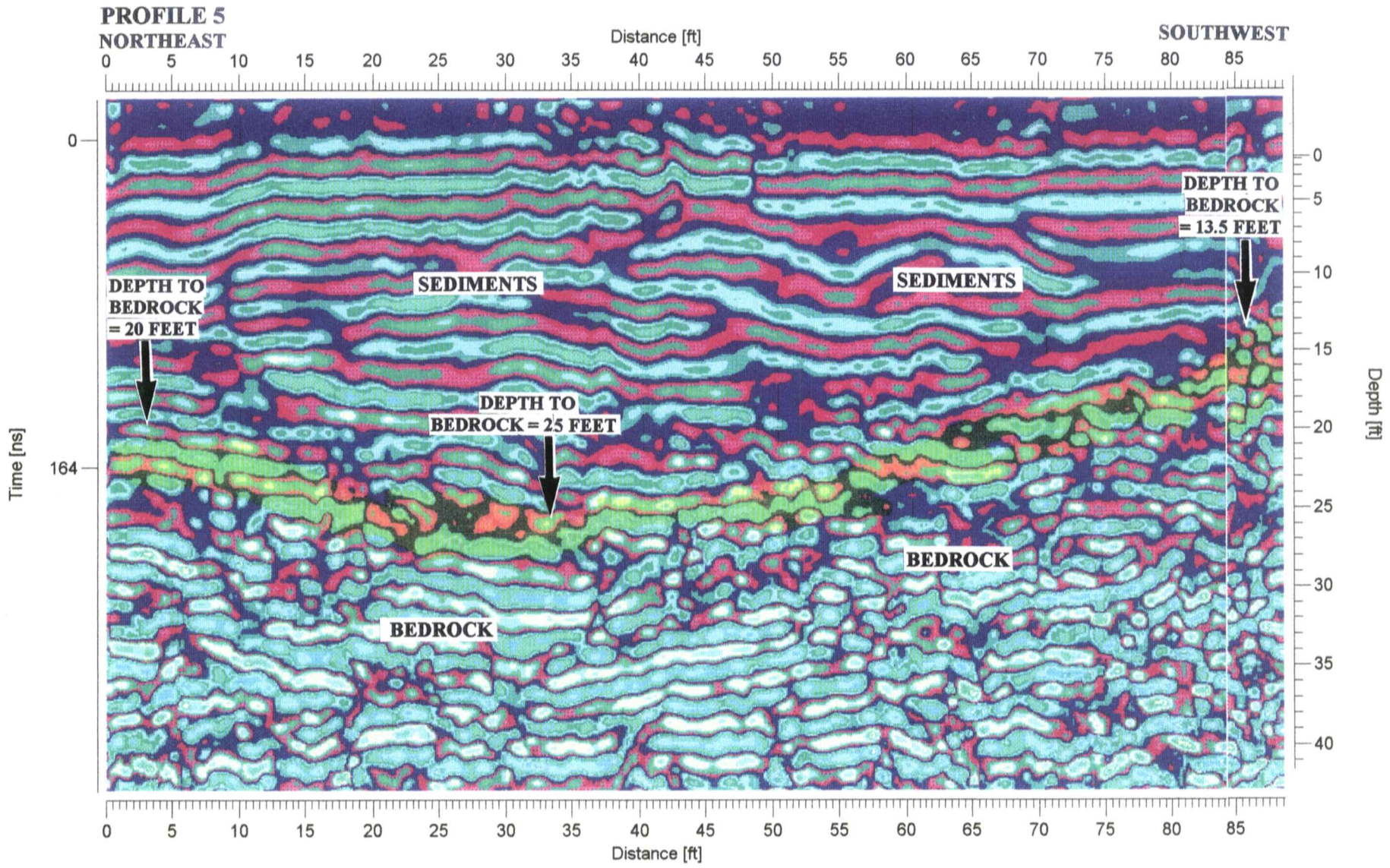
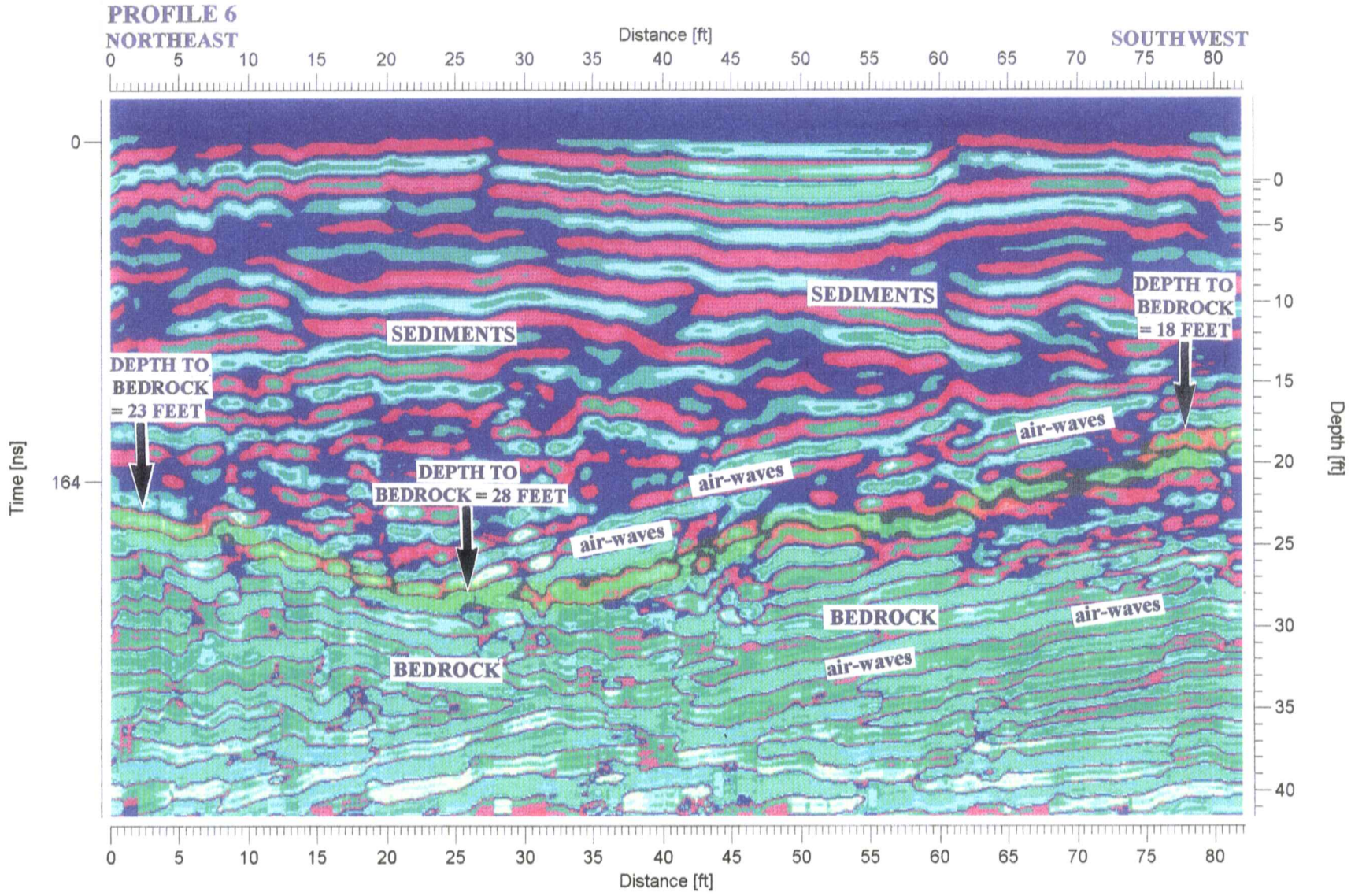

PROFILE 5
NORTHEAST
SOUTHWEST
Distance [ft]
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
Time [ns]
0
164
Depth [ft]
0 5 10 15 20 25 30 35 40
DEPTH TO BEDROCK = 20 FEET
SEDIMENTS
DEPTH TO BEDROCK = 25 FEET
SEDIMENTS
DEPTH TO BEDROCK = 13.5 FEET
BEDROCK
BEDROCK
RAMAC GroundVision
C:\dam5.rd3



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