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Seismic Refraction Data at the Los Alamos National Laboratory in the Vicinity of TA-21

By

Mike Quesada

Introduction

The Summer of Applied Geophysical Experience 1999 conducted studies at the Los Alamos Laboratory to delineate potential environmental problems in MDA-A and the surrounding area. The methods employed included GPR, Magnetics, Resistivity and Seismic Refraction. The technique of seismic refraction was utilized to locate the possible paleo-channels and is the topic of this paper. The purpose of trying to locate the paleo-channels are due to the problem of contaminant migration in the subsurface. Therefore proper interpretation of the seismic data will allow the paleo-channels to be mapped for environmental use and mitigation.

The paleo-channels are located in the subsurface and are incised into the Bandellier tuff, which is overlain by a thin layer of soil. This stratigraphic sequence is useful in the modeling of the area because of the simplicity of the units. Because of the simplicity of the lithologies all the models used are solved using two-layers.

Methods

The methods employed in the seismic survey consisted of four forty-six channel seismic lines with geophone spacing of 3ft (fig. 1). Each line consisted of approximately 12 shot gathers every 36 ft. with an airless jack hammer. The data was recorded using a Bison 9048 recording device. The topography was measured using a laser and reflector.

As can be seen in figure 1 the geometry of the seismic profiles are set up to gain the maximum information for the existence of a predicted paleo-channel. This paleo-channel is being exhumed to the northeast of the MDA-A. Because of this evidence, the configuration of the seismic lines were established.

Data processing was achieved with a script in Matlab programmed by John Ferguson. But before any modeling began, the first arrival times needed to be picked. Accurate selection of the first arrival times is problematic the further away from the origin. This is caused by the high attenuation of the Bandellier tuff (fig. 2). Because of the attenuation down the line the error involved in the first arrival picks is increased. Once the arrival times have been picked the geometry and topology of the survey line was entered into the program. With all of the information in the program, models were then created.

Interpretations

A total of three seismic lines were modeled from the environmental site. Line 5, 6, 7 and 8 are seismic lines laid out by SAGE 99 and line 4 is previous work completed by SAGE 96. The interpretation of these three lines shows a relatively thin layer of soil that is underlain by the Bandellier tuff. The first layer is approximately 3ft. thick in section and the Bandellier tuff effectively acts as a half space. The apparent velocities of the first and second layers were set to V_1=1100 ft/s and V_2=3200 ft/s respectively.

Inspection of the traces of all three lines shows some subtle shifts in the slopes of the traces. The shifts in the slopes complicate the simplest 2-D model of layer cake geology and are interpreted to be structurally related. The structure is believed to be the

ancestral channel that had been carved into the Bandellier tuff. Because of this structural complication the models created were exhaustively scrutinized for the best fit.

Inspection of the models and their best fits (figs. 3,4 and 5) shows some error within the actual and predicted values. The reason for some of the error in the traces is due to the attenuation of the Bandellier tuff and also due to the modeling of a two-layer subsurface. The apparent velocities associated with the two-layer model hold well for nonstructural complications, but the structural anomaly associated with the Bandellier tuff does complicate the model significantly. A way to correct for this complication is to insert a third layer within the paleo-channel. The third layer in the channel is assumed not to be filled with the same surface soil that we see in the first 3ft. Rather the channel is filled with colluvium. This colluvium would have a higher velocity than V_1 but less than V_2 and would therefore speed up some of the traces over the paleo-channel on the models. This third layer was not included for the reason that it would complicate the model too much. The two-layer model is a rough estimate of the paleo-channels dimensions and more importantly, its location. Therefore the two-layer model is good approximation for the environmental site.

When all three of the models are compared with one another and placed into a map view, a definite feature can be seen. Firstly, the dimensions of the paleo-channel for all three lines are roughly the same (fig. 3,4 and 5). Secondly, when projected into the map view, the locations of the paleo-channels within the seismic lines line up in accordance with the predictions (fig. 1). Unfortunately line 6 (fig. 1) was not modeled but it is strongly recommended that the data be looked at. From the projection of the

paleo-channel and the predictions made it appears that the paleo-channel runs underneath MDA-T.

Discussion/Conclusion

The data of the three seismic lines were modeled as a simple two-layer model. The two-layer model allowed for the approximate dimension and location of the paleo-channel. The paleo-channel trends in an east-west direction that passes through the modeled seismic lines. It is strongly recommended that the data from line 6 be interpreted next, in order to see if the paleo-channel extends into MDA-T. This is based on the data from ;lines 4, 5 and 8 and also from the predictions and assumptions based on the geology and geomorphology of the area.

Acknowledgements

I would like to express my gratitude to George Jiracek for encouraging me to attend SAGE. I would also like to express my thanks to John Ferguson for giving me guidance when I needed it.

References

Broxton, D.E., Eller, P.G., 1995, Earth Science Investigations for Environmental Restoration-Los Alamos National Laboratory Technical Area 21

Ferguson, J.F., refmod modeling program

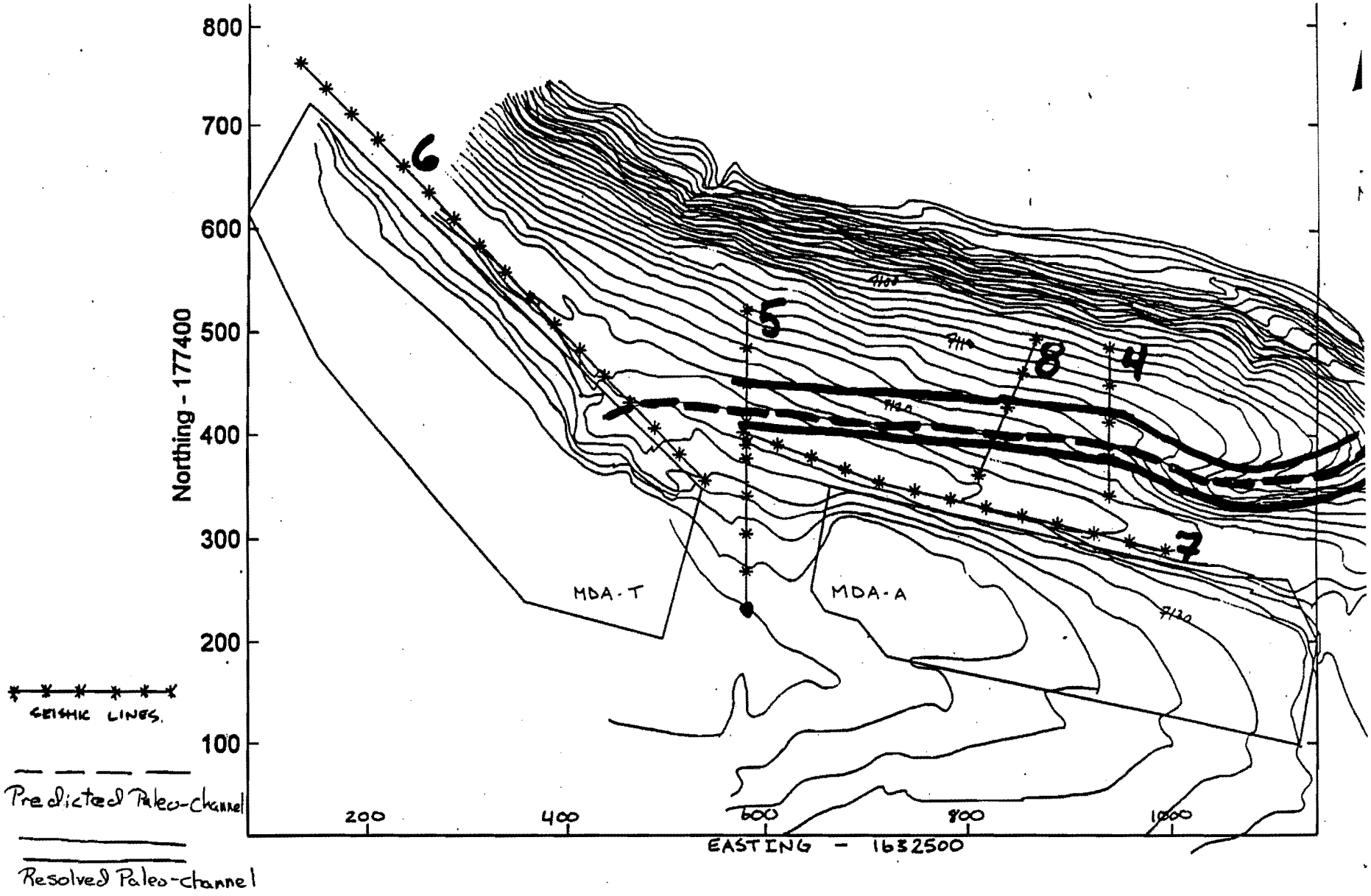
Reynolds, M.J., 1997, An Introduction to Applied and Environmental Geophysics

List of Figures

FIGURE 1.....Topographic map showing seismic lines with the predicted and resolved paleo-channel.

FIGURE 2.....Seismic data off of line 5. Dead traces are attributed to the seismic line going over paved roads. The last traces with the noise are attributed to the attenuation of the Bandellier tuff.

FIGURES 3-5.....Seismic profiles showing the paleo-channel incised into the Bandellier tuff.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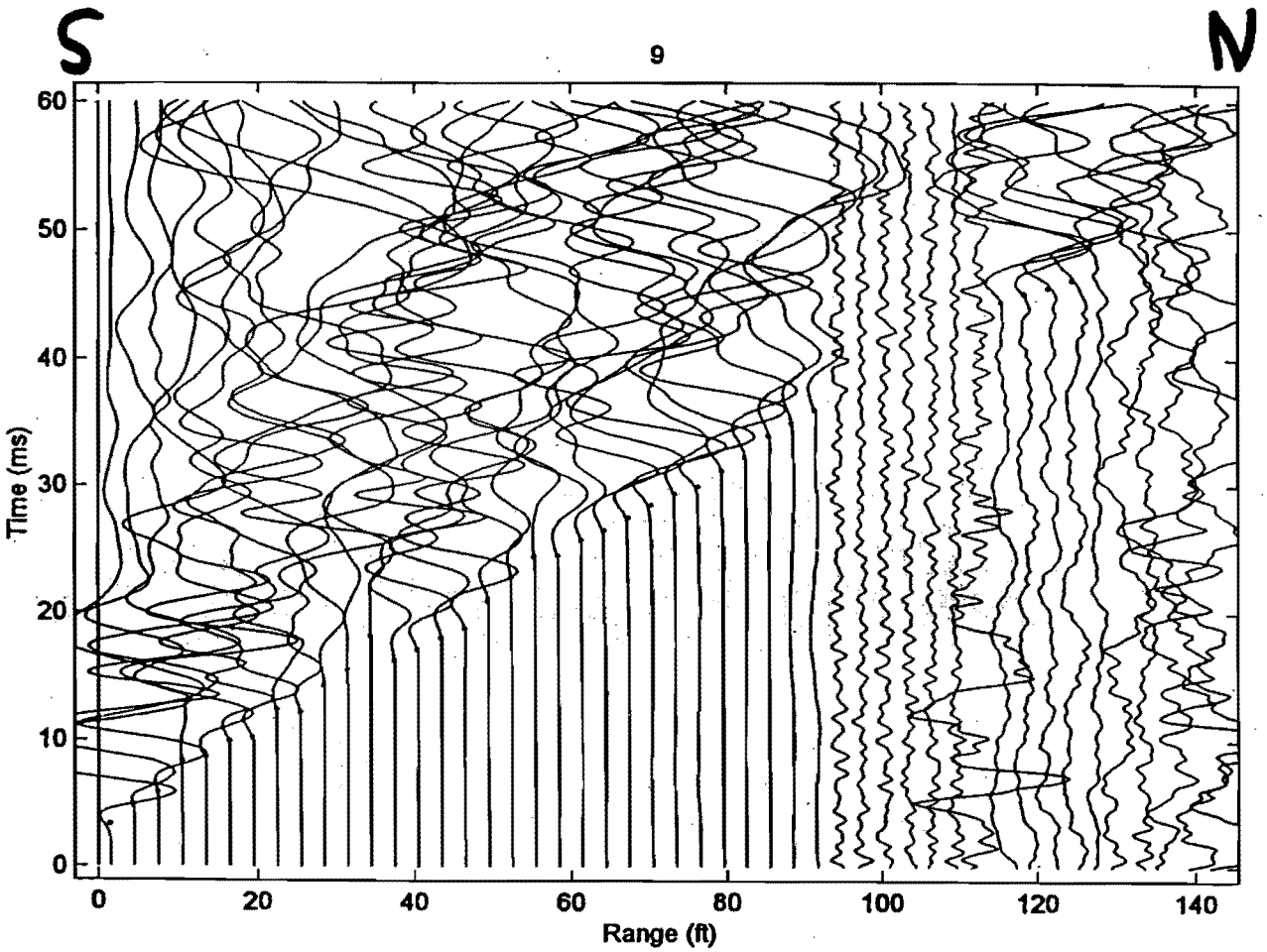
400
300
200
100
Northing - 177400
200
400
600
800
1000
EASTING - 1632500
6
5
8
4
7
MDA-T
MDA-A
SEISMIC LINES.
Predicted Paleo-channel
Resolved Paleo-channel

Figure 1



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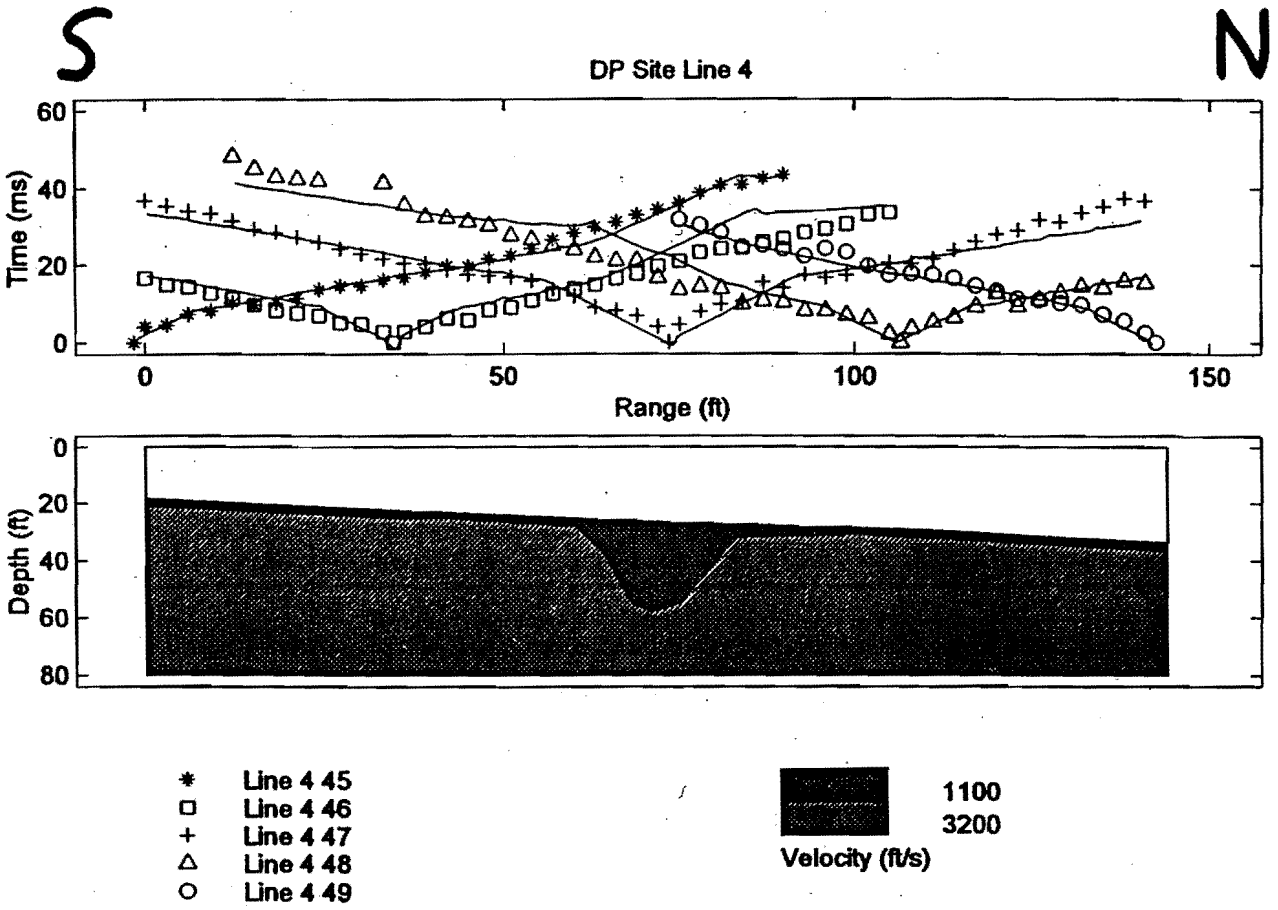
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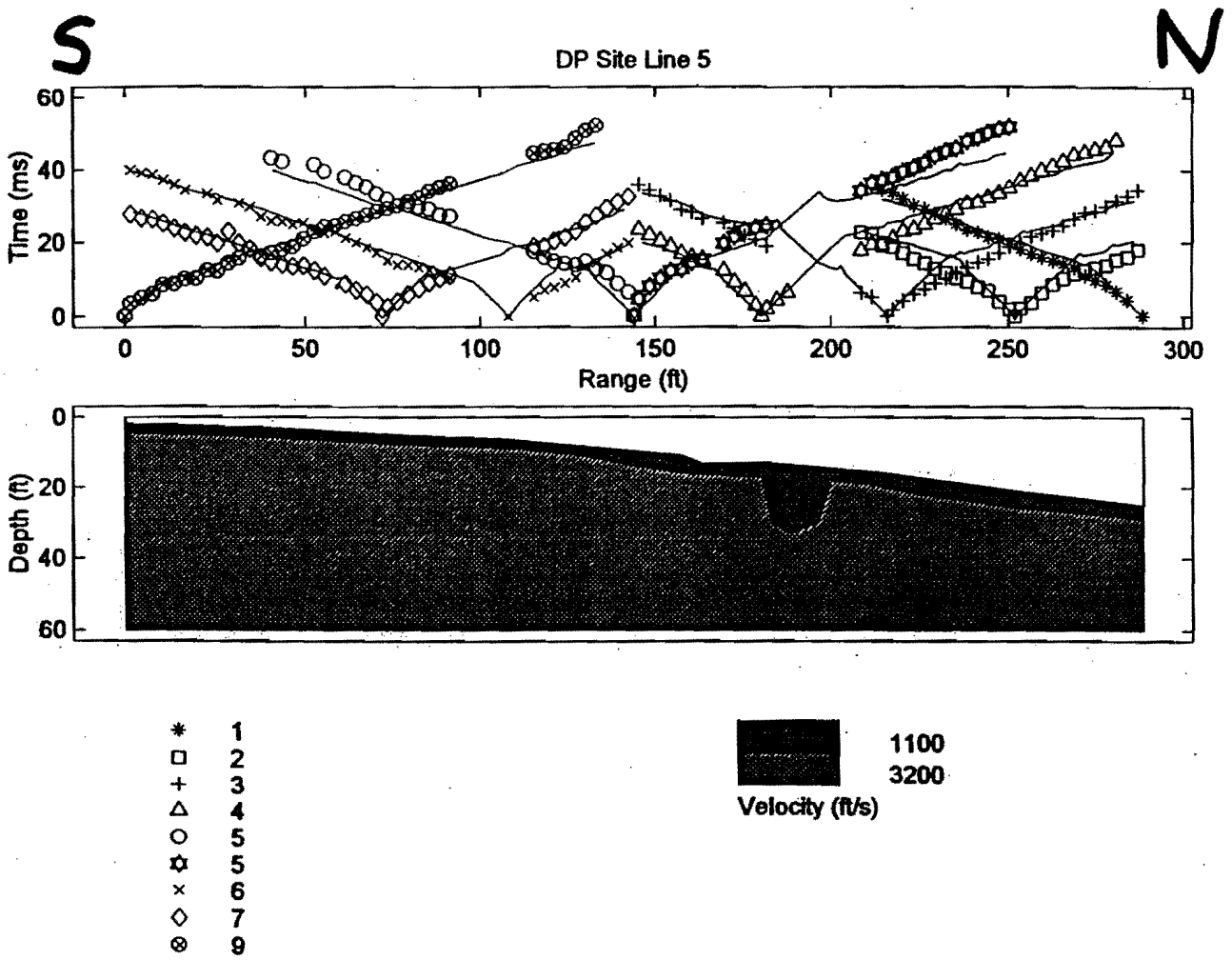
40
20
0
0
50
100
150
Range (ft)
Depth (ft)
0
20
40
60
80
Line 4 45
Line 4 46
Line 4 47
Line 4 48
Line 4 49
1100
3200
Velocity (ft/s)

Figure 3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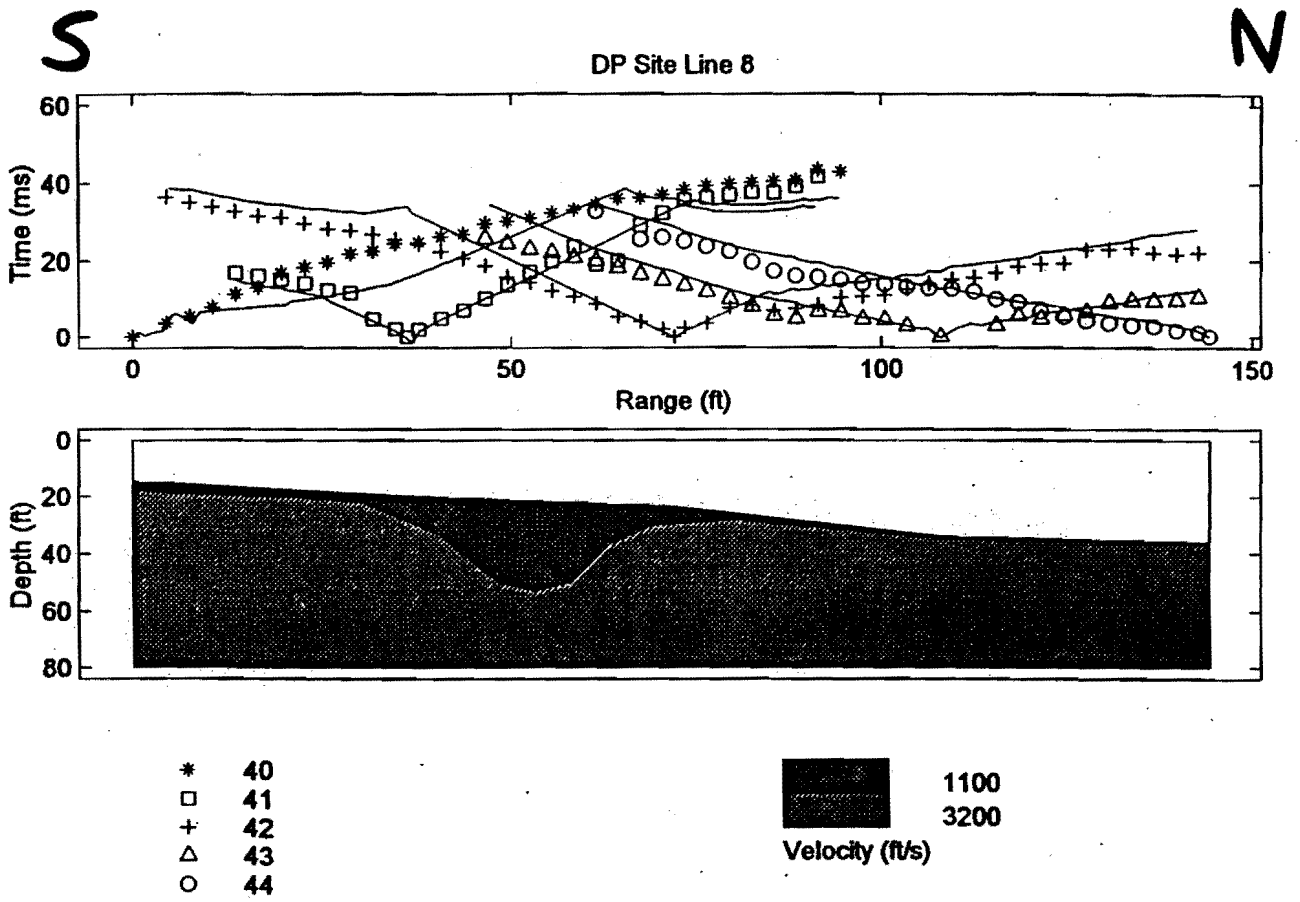
3
4
5
5
6
7
9
1100
3200
Velocity (ft/s)

Figure 4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150
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60
80
40
41
42
43
44
1100
3200
Velocity (ft/s)

Figure 5