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**The use of ground penetrating radar to map soil
physical properties that control water flow
pathways in alluvial soils**

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Abstract

Soil drainage models are vital for informing smart agricultural practices. Predicting soil drainage and zones where denitrification occurs, requires knowledge of the spatially varying subsurface features, for example soil-thickness, flow pathways, and depth to water table. Obtaining information about these features rapidly and non-invasively requires the use of geophysical techniques such as ground penetrating radar (GPR). While applications of GPR are diverse, ranging from geotechnical to archaeological investigations, to mineral and groundwater exploration, GPR has not been extensively applied in soil mapping for agricultural purposes across alluvial soils. The potential use of GPR for identifying subsurface features, such as the depth to gravel and water table which both influence soil drainage and denitrification processes, could benefit future developments in precision agriculture. To assess applicability of GPR for this purpose, this thesis presents research conducted on the alluvial soils at Dairy 1 farm, Massey University, Palmerston North. Radargrams were collected on two 0.4 ha plots, one arable and one pasture, using 200 MHz and 100 MHz antennas, in a 2-m grid pattern. Radargrams were ground-truthed with 13 soil cores and 21 auger holes, targeting different layers detected by GPR. The soil cores were analysed for bulk density, soil moisture and particle size. Using the 200 MHz antennas, soil textural banding was identified with specific reflection configurations within individual radargrams. These were represented when a contrasting textural boundary appeared as a continuous line of two to three bands. However, finer layering features were not identified. The 100 MHz antennas were able to detect depth to water table in the pasture plot. Soil moisture conditions were identified by a change in radar wave velocity. This appeared on radargrams as a difference in depth and radargram configuration shape. The use of Slice View images compiled from radargram data, assisted with identifying potential flow pathways and the depth to the water table across the pasture plot. Validation of radargrams with soil core samples indicates that GPR can obtain meaningful results from alluvial sediments ranging from sandy loams to silt loams. The use of GPR for

delineating subsurface features in alluvial soils is a promising tool that could assist with precision agricultural practices.

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Table of Contents

Abstract	i
Acknowledgements	iii
1 Introduction	1
1.1 Introduction	1
1.2 Research Aim	3
1.3 Thesis Structure	4
2 Literature Review	5
2.1 Introduction	5
2.2 Soil Hydrology	5
2.2.1 Physical Properties of Soil	5
2.2.2 Interaction of Soil and Water	9
2.2.3 Soil Water Redistribution	10
2.2.4 Geomorphic Controls for Alluvial Soil Formation	12
2.3 Introduction to Ground Penetrating Radar	14
2.3.1 Concept of GPR	15
2.3.2 Dielectric Constant & Velocity	15
2.3.3 Depth Penetration & Resolution	17
2.3.4 The Effect of Soil Water on GPR application	20
2.4 Conclusions from the Literature	22

3	Study Site and Methodology	25
3.1	Study Site	25
3.1.1	Geomorphological Setting.....	26
3.1.2	Soils.....	31
3.2	Materials and Methods	36
3.2.1	Introduction to the Experiment	36
3.2.2	Ground Penetrating Radar	40
3.2.3	Post Processing of Radargrams	42
3.2.4	Soil Measurements.....	45
3.2.5	Lab Analyses	48
4	Results	52
4.1	Soil Properties.....	53
4.1.1	Soil Texture.....	53
4.1.2	Soil Type	57
4.1.3	Soil Bulk Density	59
4.1.4	Soil Volumetric Water Content	61
4.1.5	Piezometer Measurements	62
4.1.6	Relationships between Soil Properties	63
4.2	The Relationships of Radargrams to Field Measurements	67
4.2.1	Soil Physical Properties	67

4.2.2	Soil Texture.....	70
4.2.3	Bulk Density.....	83
4.2.4	Depth to Gravel.....	85
4.3	The Relationship of Hydrological Features to Radargrams.....	85
4.3.1	Soil Moisture	85
4.3.2	Depth to Groundwater.....	94
4.4	Surface and Subsurface Contour and Soil Thickness.....	97
5	Discussion.....	102
5.1	Identifying Subsurface Materials.....	102
5.2	Seasonal Changes	105
5.3	Identifying Flow Pathways.....	106
6	Conclusions & Future Research	109
6.1	Recommendations for Future Research.....	111
	References.....	114
	Appendices.....	120
1.	Soil Core Results.....	120

List of Figures

Figure 3.1: Study site showing the two plots located at Dairy 1 farm. (1) pasture plot, (2) arable plot.	25
Figure 3.2: Geomorphological setting developed from LiDAR hillshade, showing the two research plots on the Manawatu Terrace (purple). The Tokomaru Marine Terrace to the east and south (green) and the Manawatu River to the west of the study site (Source: LiDAR hillshade provided by Horizons Regional Council).	27
Figure 3.3: The lower Manawatu River, highlighting areas of previous channels and the change in channel bedload from gravel to silt/sand at Opiki. Approximate study site location denoted by the red dot, after Page & Heerdegen (1985).	30
Figure 3.4: Soil types mapped at Dairy 1 Farm. Insets give an indication of elevation over the two research plots and signify the changes in soil type relevant to elevation change Adapted from (Pollock et al., 2003d).	32
Figure 3.5: Pasture plot soil descriptions (Pollock et al., 2003a, 2003e).	35
Figure 3.6: Arable plot soil descriptions (Pollock et al., 2003b, 2003c).	35
Figure 3.7: Grid setup, 10 m markers (red dots), 2 m markers (green dots), GPS points were recorded at each red marker. GPR lines (black lines) are spaced every 2 m. Example GPR names of two lines (blue).	38
Figure 3.8: collecting GPS points using the R8 Rover at the pasture plot. Note the white PVC markers are spaced 10 m apart and GPS recordings were taken at each marker.	39
Figure 3.9: GPR setup showing the 100 MHz antennas with battery packs and display screen assembled on a PVC cart.	41
Figure 3.10 Arable and pasture GPR grids created in GFP Edit 4. Transects were collected in a serpentine pattern over the whole plot for more efficient collection of data. An example of the serpentine pattern is shown by the directional red lines. .	42

Figure 3.11: Soil core and auger locations across the two plots. Soil cores are numbered for ease of reference when interpreting with the results section.	46
Figure 3.12: Giddings rig corer with soil corer attached.....	47
Figure 3.13: Measuring and labelling core lengths. Cores were collected in half – round PVC pipe for ease of movement off the Giddings rig.....	47
Figure 4.1: Soil core and auger locations across the two plots. Soil cores are numbered for ease of reference when interpreting with the results section.	52
Figure 4.2: Core 9 from the pasture plot, showing an increase in sand content down the soil profile to 2.11 m. At 2.20 m sand percent declined to 65% then increased to 94% at 2.44 m depth. Red arrows represent location depth of each sample.	54
Figure 4.3: Core 8 from the pasture plot, showing 4.94% clay in the Ah horizon, indicating very recent, young soils that have not had sufficient time to develop. Large textural changes are shown between 1.39 m and 1.69 m where mean grain size changes from 322 μm to 85 μm respectively and again at 2.09 m to 2.46 m grain size changes from 75 μm to 433 μm respectively.....	55
Figure 4.4: Core 2 from the arable plot, showing 7.2% clay fraction in the Ap horizon, this value is still significantly less than the same soil type mapped using S-map.....	56
Figure 4.5: Core 4 of the arable plot. Iron banding is located at 0.72 – 0.74 m and 1.05 m depth at the boundary of a textural break.	57
Figure 4.6: Core 7 from the pasture plot, with a soil depth of 0.68 m, located in the Manawatu fine sandy loam.....	59
Figure 4.7: Core 1 showing an increase in bulk density from topsoil to subsoil, before a slight decline at 0.66 m before a further increase at 1.06 m depth.	61
Figure 4.8: A comparison of bulk density and soil moisture across the four different soil textures located at the study site.	64

Figure 4.9: Volumetric water content plotted against mean grain size showing a negative exponential relationship ($R^2 = 0.6241$).....	65
Figure 4.10 Volumetric water plotted against sample depth showing no correlation between these two variables ($R^2 = 0.0025$).	66
Figure 4.11: Bulk density plotted against mean grain size showing a positive linear relationship ($R^2 = 0.3549$).....	66
Figure 4.12: Bulk density plotted against sample depth showing a positive linear relationship ($R^2 = 0.1928$).....	67
Figure 4.13: The interpretation of reflection configurations found on radargrams of the lithologic and stratigraphic properties of sediments located at Dairy 1 farm (modified from Beres & Haeni, 1991).	69
Figure 4.14: Interpreted 200 MHz radargram of arable Long 0 line, with soil Cores 1, 4 and 5. Auger samples assessed depth to gravel (green stars).....	71
Figure 4.15: Core 5 of the arable plot showing the large textural changes within the C horizon from 1.09 m to 1.51 m depth where grain size varied from 38 μm to 400 μm respectively.....	72
Figure 4.16: Interpreted radargram of the arable Short 50 line, with soil Cores 1, 2 and 3. Auger samples assessed depth to gravel (green stars).....	73
Figure 4.17: Core 3 showing a textural change between 0.81 m to 1.34 m depth from coarse sand to a fine/med sand band.....	74
Figure 4.18: Interpreted 200 MHz radargram of the pasture plot Long 12 line, with soil Cores 6 and 7. Depth to gravel (green stars).....	76
Figure 4.19: Core 6 showing interbedded layers of sands and silts throughout the C horizon.	77

Figure 4.20: Interpreted 200 MHz radargram of the pasture plot Short 36 line. Soil Cores 10 and 11 refer to positions A and B respectively. Depth to gravel (green stars) (Velocity adjusted to 0.065 m/ns)..... 78

Figure 4.21: Core 10 of the pasture plot showing very coarse silt from 1.39 m to 1.67 m depth overlying medium sand at 1.81 m depth. 79

Figure 4.22: Core 11 of the pasture plot showing very fine sand at 0.78 m depth. .. 80

Figure 4.23: Interpreted 200 MHz radargram of the pasture plot Short 92 line. Soil cores 12 and 13 refer to positions A and B respectively. Depth to gravel (green stars)..... 81

Figure 4.24: Core 12 of the pasture plot highlighting the change between fine sand at 0.56 m to very fine sand at 0.63 m depth. This fine sand layer is represented in the Short 92 radargram (Fig 4.23)..... 82

Figure 4.25: Core 13 of the pasture plot showing the very coarse silt layer at 0.84 m depth. 83

Figure 4.26: A 200 MHz radargram of the Short 50 line from the arable plot showing the location of the highest and lowest bulk density values per core with no significant features reflecting these values. 84

Figure 4.27: A 200 MHz radargram of the Short 36 line from the pasture plot (velocity adjusted to 0.065 m/ns). Augered gravel depth = green stars. 84

Figure 4.28: Interpreted 200 MHz radargram of the pasture plot Short 14 line showing soil Cores 8 and 9. Depth to gravel (green stars). 86

Figure 4.29: Comparison of the 200 MHz surveys conducted in September 2015 (top radargram) and February 2016 (lower radargram) at the pasture plot of the Short 36 line. 88

Figure 4.30: The Short 14 line showing a comparison of the 200 MHz surveys conducted in spring, September 2015 (top radargram) and summer, February 2016

(lower radargram) at the pasture plot. Red arrows indicate the greatest response seen between the spring and summer radargrams. The first arrow on the left indicates a narrower hyperbole in the spring radargram compared to the summer radargram, indicating a quickening velocity from wet to drier conditions. 89

Figure 4.31: Comparison of the 200 MHz surveys conducted in September 2015 (top radargram) and February 2016 (lower radargram) at the pasture plot of the Short 92 line..... 90

Figure 4.32: Comparison of the 200 MHz surveys conducted in September 2015 (top radargram) and February 2016 (lower radargram) at the pasture plot of the Long 12 line..... 91

Figure 4.33: 200 MHz Slice View of the pasture plot taken in September 2015 (Velocity 0.09 m/ns). Three depths are shown for comparison with radargrams. Increased signal strength is shown in red and attenuated signal in deep blue. 93

Figure 4.34: 200 MHz Slice View during February 2016 of the pasture plot showing a decrease in signal strength compared to the September 2015 images in Figure 4.33. Velocity has been adjusted to 0.1m/ns. 94

Figure 4.35: Interpretation of the 100 MHz survey of the pasture plot Long 12 line showing the groundwater reflector and hyperbolic reflectors. 95

Figure 4.36: Interpretation of the 100 MHz survey of the pasture plot Short 14 m line. A transitional zone between the gravel surface and water table is represented by a slightly attenuated signal. 96

Figure 4.37: 100 MHz Slice View images of the pasture plot in February 2016. Three depths are shown for comparison with radargrams. Increased signal strength is shown in red and attenuated signal in deep blue. 97

Figure 4.38: Arable surface elevation and contour (A), gravel elevation and contour (B), and soil thickness (C). 99

Figure 4.39: Pasture surface elevation and contour (A), gravel elevation and contour (B), and soil thickness (C). 101

List of Tables

Table 2.1: The size and function of soil pores adapted from McLaren & Cameron, (1996). 7

Table 2.2: Dielectric constant, velocity and attenuation found in typical geological materials (Davis & Annan, 1989). 16

Table 3.1: Physical properties found in the Rangitikei silt loam, Manawatu sandy loam and Manawatu silt loam over sand according to S-map data (Landcare Research, 2015a, 2015b, 2015c). 34

Table 4.1: Average percentages of sand and clay ranges across the arable and pasture plots. 53

Table 4.2: Average soil dry bulk density values across the arable and pasture plots. Note pasture plot soil cores with an A horizon >0.20 m were used for these calculations. 59

Table 4.3: Average volumetric water content across the arable and pasture plot within each horizon. 62

Table 4.4: Depth to groundwater level taken from four piezometers (P1, P2, P3, and P4) located adjacent to the pasture plot. 63

Table 5.1: Prominence of mean grain size across the study site 103

