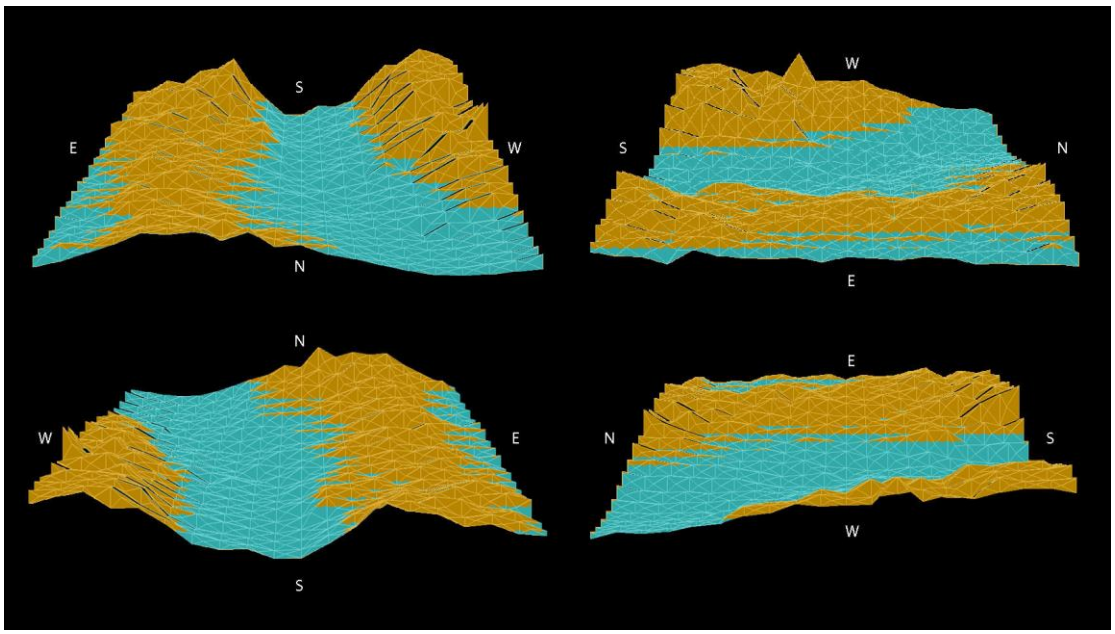
A Resistivity Survey at Dairsie Mill, Fife

Mike Middleton



Survey type: Equipment Test
Survey number: 001
Model: D1.0

Dairsie Mill (NO41NW 64)

Mike Middleton
1 Dairsie Mains Cottage,
Dairsie, Fife, KY15 4RL
7th September 2013

Abstract
This report details the successful first test of an amateur, homemade resistivity meter.

Aim

The aim of this survey is to test a newly built resistivity survey meter over a known negative feature to assess if the survey meter is able to detect it. For the sake of future reference I shall refer to the meter as the model D1.0 The aim is both to refine the design of the machine and to review the quality of the results.

The D1.0 Resistivity Meter

The resistivity meter is a 6 volt DC meter built by the author to specifications published by John Stanley in Electronics Today International (Stanley, 1981). The meter is calibrated, using the four probe Wenner Method (Wenner, 1915), to focus at 45cm depth and has four, 6cm probes, set 75cm apart. Readings are recorded manually and the results are processed using the standard equation of resistivity:

resistivity = 2 x π x probe separation x resistance

where:

resistance =	(voltage B - voltage A) ÷ current
voltage A =	the voltage recorded between the centre probes when <u>no</u> current is passed between the outer probes.
voltage B =	the voltage between the centre probes while a current is passed between the outer probes using a 6v cell.
current =	the current between the outer probes when a 6v cell is attached to the outer probes.

Being a DC meter it is possible for there to be interference from the earth's gravitational field. To minimise the influence of this, gravimetric force readings are taken for both polarities and averaged.

The Survey Area
Two known negative features were chosen as the focus of the survey. These were two mill lades just north of Dairsie Mill (NO41NW 64) and both are shown on the 1854 Ordnance Survey 6 inch map of Fife. By 1893, the date of the Ordnance Survey 2nd edition revision, only the lade to the west is shown and on modern maps neither are shown.

A 20m grid was set out using bamboo pegs and centred on NO 41432,15804. The survey was begun at the NW corner, moving west to east to the NE corner. Each row was then recorded from N to S over two days from the 31st August to 1st September. At the time of the survey the field was in long pasture and weather conditions were dry.

The first five rows were recorded by manually inserting each probe. The next three rows were recorded using a rigid frame to hold the probes. The frame was used for three rows (rows 6 to 8) but it's rigidity made it difficult to guarantee all four probes were properly inserted. The results were processed at row 8 to assess these concerns over probe contact. The results indicated that there were problems with rows 7 and 8. The frame was modified so that the two centre probes were fixed to the rigid frame while the two outer probes were attached to bamboo canes and inserted manually. The data for rows 7 and 8 were recorded again, using the modified frame, and the remainder of the survey was carried out using the same set up.

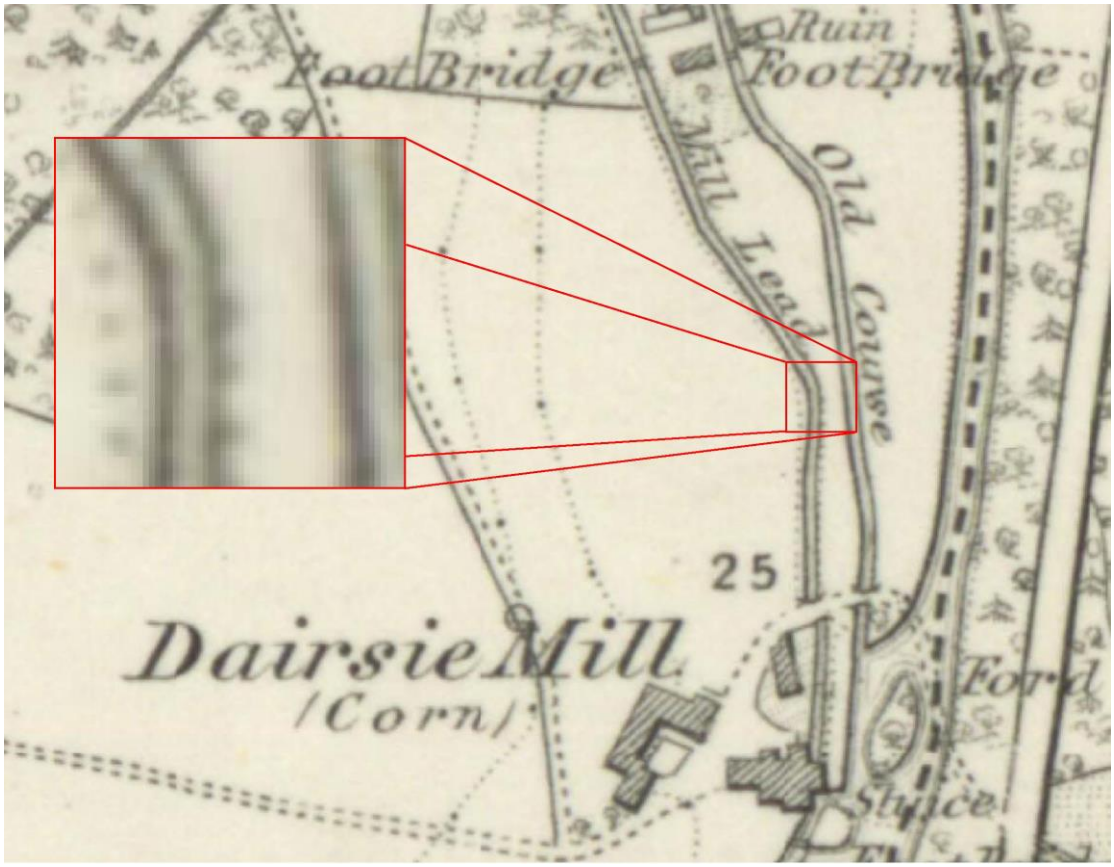


Figure 1: 1st Edition Ordnance Survey 6 inch map of Fife showing the two mill lades targeted and the survey area. (Map courtesy of the NLS: Fife and Kinross Sheet VIII.SW, Sheet 11 (surveyed 1854, published 1856))

Results

The results show that the D1.0 resistivity meter has successfully mapped the two negative features. The numeric results are shown in Appendix 1.

It became obvious early in the survey that there was a minor wiring error. All the results produced a negative resistivity and indicated that the voltmeter connections needed to be reversed. For the sake of consistency this was done after the survey was completed and the results were converted to positive values.

All calculations were carried out using Microsoft Excel and the data was plotted using Resistivity Plotter v1.1 (software written by the author).

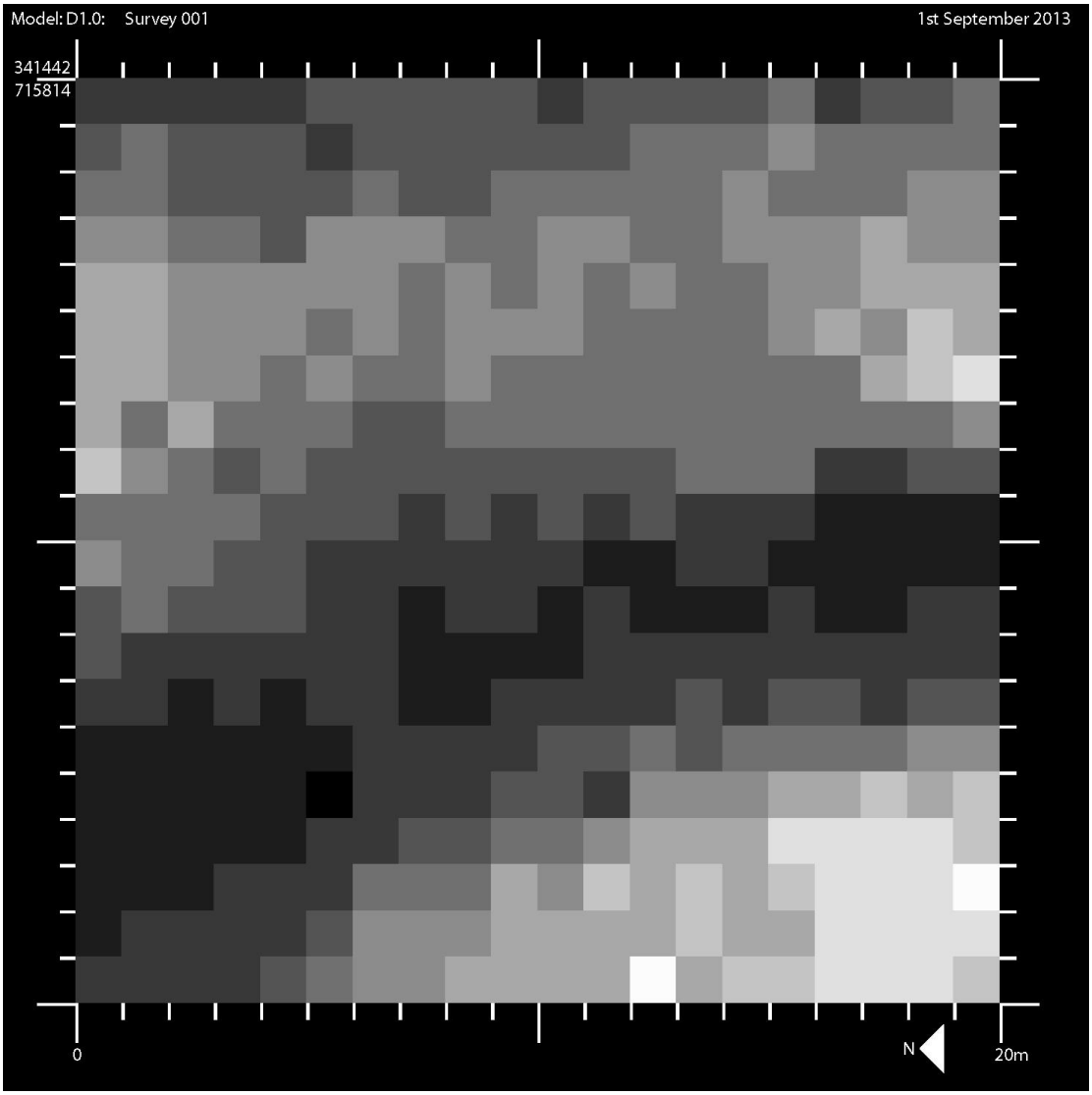


Figure 2: Grey scale plot showing darker for points of low resistance and light for high resistance. See appendix 1 to map values to shade. Plotted using Resistivity Plotter v1.1.

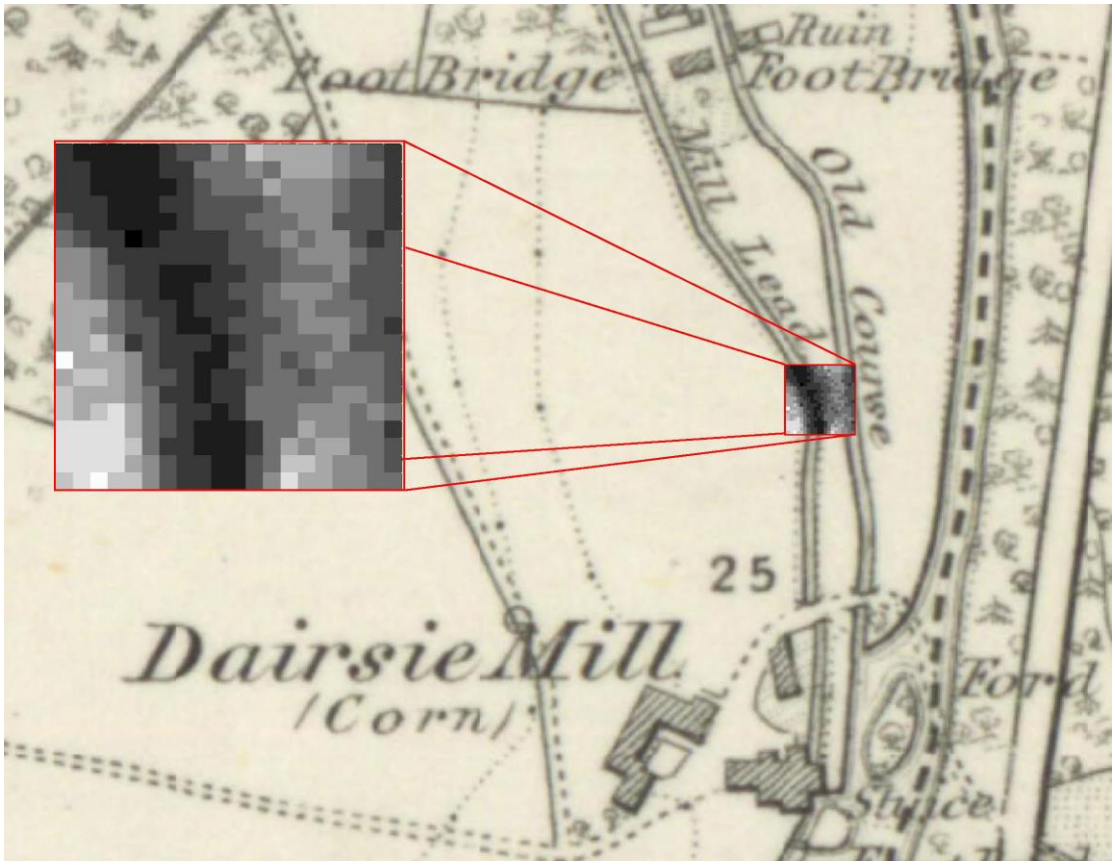


Figure 3: 1st Edition Ordnance Survey 6 inch map of Fife showing the two mill lades targeted with the survey plot overlaid. (Map courtesy of the NLS: Fife and Kinross Sheet VIII.SW, Sheet 11 (surveyed 1854, published 1856))

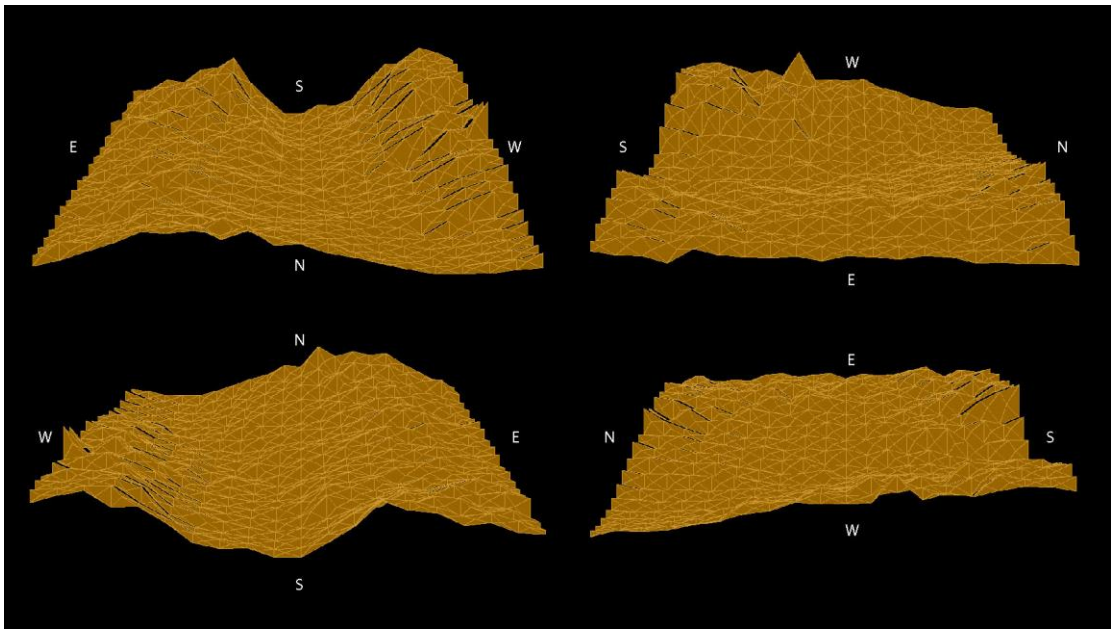


Figure 4: Digital terrain maps showing four views of the survey results. Plotted using Resistivity Plotter v1.1.

Acknowledgements
Thanks to Morgan, Bill Hamilton and Peter McKeague. You know who you are and you know what you did.

Bibliography

Stanley, J (1981), *'Earth Resistivity Meter,'* Electronics Today International Magazine 1981
http://www.nps.gov/mwac/publications/pdf/spec1.pdf [Accessed 31st August 2013]

Bevan, B (1998), *'Geophysical Exploration for Archaeology,'* Midwest Archaeological Centre Report No. 1, Nebraska
http://www.geotech1.com/pages/geo/projects/erm2/erm2_150.pdf [Accessed 31st August 2013]

Wenner, F (1915), *'A Method of Measuring Earth Resistivity,'* Bull, National Bureau of Standards, Bull 12(4) 258, p. 478-496
http://archive.org/details/met12469478191625825 8unse [Accessed 31st August 2013]

Appendix 1: Results

Grid size: 1m
Probe separation: 0.75m
Probe size: 0.06m
Cell: 6v
Results in ohms per metre square
Coordinates using OSGB36 for each corner

E341442 N715814 E341442 N715794

171	184	180	194	187	238	251	223	238	249	206	246	236	242	259	309	186	252	261	290
219	299	222	232	227	210	262	262	250	228	261	280	304	299	349	357	294	349	333	305
290	295	262	262	224	261	299	277	268	299	305	281	301	324	395	346	313	340	395	386
362	351	328	308	274	369	388	372	326	312	387	365	342	321	355	414	373	452	370	367
453	425	369	402	373	382	407	305	396	336	353	319	363	332	307	351	382	467	446	472
443	427	399	383	366	330	402	335	413	391	361	344	348	284	331	382	432	390	504	491
465	444	357	383	317	361	335	306	353	329	314	309	282	339	300	311	306	433	513	572
427	326	433	325	340	316	267	279	290	317	281	301	315	301	328	296	288	330	298	363
508	395	328	273	289	246	251	226	270	251	220	236	273	283	333	333	207	206	224	225
342	337	336	283	259	223	243	207	227	205	221	171	216	170	212	159	131	117	108	105
355	294	296	259	245	201	205	186	210	153	146	120	126	148	158	122	98	99	97	103
277	286	258	238	239	203	175	138	150	172	103	148	133	139	141	148	138	128	145	179
239	210	213	202	192	191	149	115	122	111	138	200	189	173	176	184	189	166	181	175
188	153	141	146	128	144	154	135	143	149	170	153	202	218	200	234	258	207	236	221
140	126	105	119	120	139	150	150	194	201	233	271	280	265	285	309	319	310	361	390
104	96	92	99	108	76	187	188	214	237	266	191	390	386	397	436	481	544	480	522
102	97	98	116	121	193	212	236	261	344	344	362	488	466	426	598	586	620	624	520
110	127	133	147	168	192	304	335	345	448	411	541	452	553	461	534	612	615	628	656
135	152	160	174	194	215	372	386	400	473	442	448	476	515	445	449	626	589	601	617
153	209	201	214	260	290	355	381	458	441	449	453	698	482	537	507	561	598	595	558

E341422 N715814 E341422 N715794

Appendix 2: Photos

	Photo of D1.0 Resistivity meter	DSCF9663.jpg
	Photo of Mill field Dairsie looking SE	DSCF9655.jpg
	Photo looking NE over survey grid.	DSCF9665.jpg

Appendix 3: Digital Archive

Report_survey_001_A resistivity survey at Dairsie Mill	Report	.doc (MS office 2000)
Survey_001_data	Data in 5 worksheets: Tab 1: raw Data entry (voltage B: voltage A: current Tab 2: Resistivity = 2 x π x probe separation x resistance Tab 3: Averaging polarities Tab 4: Rounding to integer Tab 5: Data Export format	.xls (MS office 2000)
survey_001_oldmap	Fig1	.jpg
survey_001_plot	Fig2	.jpg
survey_001_oldmap_plus_result	Fig3	.jpg
survey_001_all_plots	Fig4	.jpg
recon_all	Cover image: DTM plus shading to suggest water.	.jpg
DSCF9655	Photo of Mill field Dairsie looking SE.	.jpg
DSCF9663	Photo of D1.0 Resistivity meter.	.jpg
DSCF9665	Photo looking NE over survey grid.	.jpg
Res_survey_001_rectified_plots	Folder containing rectified survey plots	Folder
Dairsie_plot_01_rec	In folder: Res_survey_001_rectified_plots	.jgw
Dairsie_plot_01_rec	In folder: Res_survey_001_rectified_plots	.jpg
Dairsie_plot_01_rec	In folder: Res_survey_001_rectified_plots	.jpg.aux
Dairsie_plot_01_rec	In folder: Res_survey_001_rectified_plots	.jpg.ovr