River Murray Corridor RESOLVE AEM Survey Holistic Inversion Data

1. Introduction

This document describes the contents of the data directories containing conductivity model data derived from a holistic inversion of the River Murray Corridor RESOLVE AEM survey data. The conductivity model datasets are:

- grids of conductivity model layers output from the inversion; the layers are relative to ground surface (sub-folder: layers)
- grids of depth slices of regular thicknesses generated from the layers; the depth slices are relative to natural surface (sub-folder: slices_depth)
- grids of depth slices relative to a smooth surface that approximates the River Murray floodplain (sub-folder: slices_floodplain)
- grids of depth slices relative to a smooth surface that approximates the regional water table (sub-folder: slices_watertable)

The disk also contains:

- Explanatory document (this document)
- Grids of the floodplain used as the reference for the grids in the sub-folder: grids_depth_slice (subfolder: floodplain_ elevation).

Note that the basic (response) data are in a separate product which is distributed by Geoscience Australia.

2. Brief details of inversion

The holistic inversion methodology used to generate the conductivity model data is described in:

> Brodie, R. & Sambridge, M., 2006, *A holistic approach to inversion of frequency-domain airborne EM data*, Geophysics, 71, 6, G301 – G312.

Fundamentally, the holistic inversion algorithm solves for the coefficients of the nodes on 18 separate 2-D bi-cubic B-spline meshes. Each spline mesh corresponds to a layer in the 18-layer conductivity model. The nodes of the meshes were located on 100m x 100m centres. Since the coefficients of the spline nodes (which are analogous to the coefficients a, b and c in the polynomial function $f(x) = ax^2 + bx + c$) are abstract mathematical quantities and generally not that useful to most end users, the holistic inversion algorithm outputted the data on a series of 40m x 40m layer conductivity grids. This was achieved by evaluating the splines at the centre of the output grids' cells (which is analogous to computing the value of f(x) for a given value of x). Once the layer grids were constructed several additional products were also derived. These are described in Sections 6 to 9.

3. Sub-areas

The survey (summary of acquisition is in Appendix 1) was flown in eight different sub-blocks: A1, A2, B1, B2, B3, B4, B5, and C. (See Figure 1 for their geographic locations, and Appendix 2 for some informal names for them that may appear in documents about the survey and its interpretation.) However the holistic inversion on the survey data was carried out on five separate sub-blocks (AWEST, AEAST, B123, B45 and C) as shown in Figure 1.

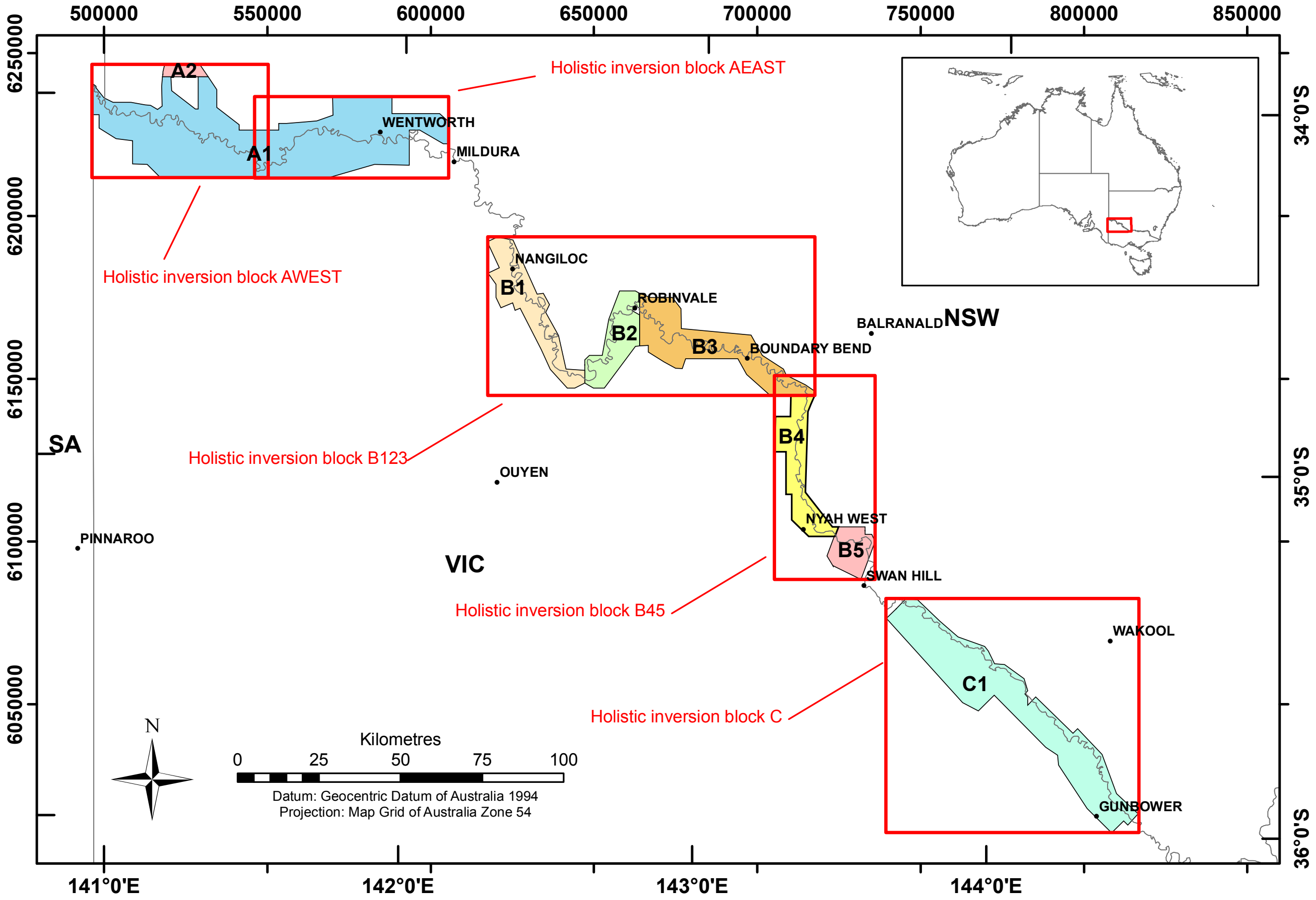

Figure 1. Locality map showing the extent of different data acquisition sub-blocks and the holistic inversion sub-blocks.

4. Layer conductivity grids (sub-folder: layers)

The layer conductivity grids represent the conductivity in siemens per metre (S/m) of each layer of the 18 layer conductivity model. They have been derived by direct evaluation of the fundamental holistic inversion spline mesh functions at the grid cell centres as described in Section 2. There are always 18 layers in the model and the thickness of each layer is constant over the whole survey area. The layer thicknesses and depth extents are shown in Table 1. All depths are relative to the natural surface.

Table 1. Layer thicknesses and depth extents

Layer number	Thickness (m)	Depth to top (m)	Depth to bottom (m)	Conductivity grid filename
01	2.00	0.00	2.00	layer_01.ers
02	2.20	2.00	4.20	layer_02.ers
03	2.42	4.20	6.62	layer_03.ers
04	2.66	6.62	9.28	layer_04.ers
05	2.93	9.28	12.21	layer_05.ers
06	3.22	12.21	15.43	layer_06.ers
07	3.54	15.43	18.97	layer_07.ers
08	3.90	18.97	22.87	layer_08.ers
09	4.29	22.87	27.16	layer_09.ers
10	4.72	27.16	31.87	layer_10.ers
11	5.19	31.87	37.06	layer_11.ers
12	5.71	37.06	42.77	layer_12.ers
13	6.28	42.77	49.05	layer_13.ers
14	6.90	49.05	55.95	layer_14.ers
15	7.59	55.95	63.54	layer_15.ers
16	8.35	63.54	71.90	layer_16.ers
17	9.19	71.90	81.09	layer_17.ers
18	∞	81.09	∞	layer_18.ers

The grids are stored in ER Mapper binary floating point raster grid format (IEEE 4 byte reals) with an associated header (.ers) file. The folder and file naming convention for the binary grid and header is as follows:

aa\layers\layer_nn.ers (header file),

aa\layers\layer_nn (binary grid file),

where aa represents the holistic inversion sub-block name (e.g., b123) and nn represents the layer number.

5. Depth slice grids (sub-folder: slices_depth)

The depth slice grids represent the average conductivity in S/m of various regular intervals (Table 2). They have been derived from the layer conductivity grids by a weighted average of the layers that intersect the depth interval. For example a slice between 5m and 10m depth would be constructed as follows;

(1.62×layer 3 conductivity + 2.66×layer 4 conductivity + 0.72×layer 5 conductivity)/5.0

The grids are stored in ER Mapper binary floating point raster grid format (IEEE 4 byte reals) with an associated header (.ers) file. The folder and file naming convention for the binary grid and header is as follows:

aa\slices_depth\depth_slice_dt_db.ers (header file),

aa\slices_depth\depth_slice_dt_db (binary grid file),

where aa represents the holistic inversion sub-block name (e.g., b123) and dt and db represent the depth to the top and bottom of the interval respectively. The depth slice intervals are shown in Table 2.

Table 2. Depth slice intervals

Depth to top (m)	Depth to bottom (m)	Conductivity grid filename
0	2	depth_slice_00_02.ers
0	5	depth_slice_00_05.ers
0	10	depth_slice_00_10.ers
2	5	depth_slice_02_05.ers
5	10	depth_slice_05_10.ers
10	15	depth_slice_10_15.ers
15	20	depth_slice_15_20.ers
20	25	depth_slice_20_25.ers
25	30	depth_slice_25_30.ers
30	35	depth_slice_30_35.ers
35	40	depth_slice_35_40.ers
40	45	depth_slice_40_45.ers
45	50	depth_slice_45_50.ers
50	55	depth_slice_50_55.ers
55	60	depth_slice_55_60.ers

6. Floodplain slice grids (sub-folder: slices_floodplain)

The floodplain slice grids represent the average conductivity in S/m of various intervals relative to the elevation above or below a smooth surface that approximates the River Murray floodplain. They are not slices that follow a certain depth extent, but are relative to the gentle upstream/downstream incline/decline of the river and floodplain. This smooth floodplain surface was generated by gridding (then extrapolating and smoothing) elevation data that lay inside polygons, that from an independent geomorphic interpretation had been interpreted to represent the recent floodplain sediments of the River Murray.

The slices have been derived from the layer conductivity grids by a weighted average of the layers that intersect the interval. To do this it was necessary to use a different weighting for each grid cell depending on the actual surface elevation and the smooth floodplain surface elevation at that cell.

The grids are stored in ER Mapper binary floating point raster grid format (IEEE 4 byte reals) with and associated header (.ers) file. The folder and file naming convention for the binary grid and header is as follows:

aa\slices_floodplain\floodplainslice_bbb_ttt.ers (header file),

aa\slices_floodplain\floodplainslice_bbb_ttt (binary grid file),

where aa represents the holistic inversion sub-block name (e.g., b123) and bbb and ttt represent the distance from the smooth floodplain surface to the bottom and top of the interval respectively. Positive values of bbb or ttt mean that the the interval is above the floodplain surface and negative values mean that the the interval is below the floodplain surface The floodplain slice intervals are shown in Table 3.

Note that in the upper (+ve) floodplain slices many of the cells in the grid will be set to the null (missing) value because at that cell the slice will be entirely above ground surface. For some sub-blocks, the upper slices are above the ground surface everywhere on the grid (all values are set to null) and accordingly have not been included in the dataset.

Table 3. Floodplain slice intervals

Distance from smooth floodplain surface to bottom of interval (m)	Distance from smooth floodplain surface to top of interval (m)	Conductivity grid filename
+40	+35	floodplainslice_+40_+35.ers
+35	+25	floodplainslice_+35_+25.ers
+30	+20	floodplainslice_+30_+20.ers
+25	+20	floodplainslice_+25_+20.ers
+20	+15	floodplainslice_+20_+15.ers
+15	+10	floodplainslice_+15_+10.ers
+10	+05	floodplainslice_+10_+05.ers
+06	+04	floodplainslice_+06_+04.ers
+05	+00	floodplainslice_+05_+00.ers
+04	+02	floodplainslice_+04_+02.ers
+02	+00	floodplainslice_+02_+00.ers
+00	-05	floodplainslice_+00_-05.ers
+00	-02	floodplainslice_+00_-02.ers
-02	-04	floodplainslice_-02_-04.ers
-04	-06	floodplainslice_-04_-06.ers
-05	-10	floodplainslice_-05_-10.ers
-06	-08	floodplainslice_-06_-08.ers
-08	-10	floodplainslice_-08_-10.ers
-10	-12	floodplainslice_-10_-12.ers
-10	-15	floodplainslice_-10_-15.ers
-12	-14	floodplainslice_-12_-14.ers
-14	-16	floodplainslice_-14_-16.ers
-15	-20	floodplainslice_-15_-20.ers
-16	-18	floodplainslice_-16_-18.ers
-18	-20	floodplainslice_-18_-20.ers
-20	-25	floodplainslice_-20_-25.ers
-25	-30	floodplainslice_-25_-30.ers
-30	-35	floodplainslice_-30_-35.ers
-35	-40	floodplainslice_-35_-40.ers
-40	-45	floodplainslice_-40_-45.ers
-45	-50	floodplainslice_-45_-50.ers
-50	-55	floodplainslice_-50_-55.ers
-55	-60	floodplainslice_-55_-60.ers

The floodplain surface, which is the elevation datum for the slices, is in the folder floodplain_elevation.

The floodplain slice grids are stored in ER Mapper binary floating point raster grid format (IEEE 4 byte reals) with and associated header (.ers) file. The file naming convention for the binary grids are shown in Table 3. and header is as follows:

7. Watertable slice grids (sub-folder: slices_watertable)

The watertable slice grids represent the average conductivity in S/m of various intervals relative to the elevation above or below a smooth surface that approximates the regional watertable. They are not slices that follow a certain depth extent, but are relative to the gentle upstream/downstream incline/decline of the watertable. This watertable surface was generated by gridding (then extrapolating and smoothing) watertable data from bores and river height data.

Table 4 lists and describes the watertable slice grids.

Table 4. Floodplain slice intervals

Conductivity grid filename	Description
floodplain_watertable_averageconductivity.ers	Average conductivity (S/m) of the variable thickness interval between the generalised floodplain surface and the watertable surface. Calculated by a weighted average of the layer conductivity grids.
floodplain_watertable_conductance.ers	Total conductance (S) of the variable thickness interval between the generalised floodplain surface and the watertable surface.
floodplain_watertable_thickness.ers	Thickness (m) of the variable thickness interval between the generalised floodplain surface and the watertable surface.
surface_watertable_averageconductivity.ers	Average conductivity (S/m) of the variable thickness interval between natural surface and the watertable. Calculated by a weighted average of the layer conductivity grids.
surface_watertable_conductance.ers	Total conductance (S) of the variable thickness interval between natural surface and the watertable.
surface_watertable_thickness.ers	Thickness in metres (m) of the variable thickness interval between natural surface and the watertable.
watertableslice_+00_-05.ers	Average conductivity (S/m) from 0 to 5 meters below the watertable surface. Calculated by a weighted average of the layer conductivity grids.
watertableslice_+00_-30.ers	Average conductivity (S/m) from 0 to 30 meters below the watertable surface. Calculated by a weighted average of the layer conductivity grids.

Appendix 1. AEM survey details

System:	RESOLVE
Contractor:	Fugro Airborne Surveys
Data sampled:	Frequency domain electromagnetics Magnetics Elevation model
Total distance flown:	24 069 km
Nominal flying height:	Helicopter – 60 m Bird – 30 m
Survey period:	February – May 2008

Line, tie spacings and directions:

Block	*Line spacing (m)*	*Line direction (º grid)*	*Tie spacing (m)*	*Tie direction (º grid)*
A1	200	0	2 000	90
A2	200	90	2 000	0
B1	200	65	2 000	155
B2	200	120	2 000	30
B3	200	0	2 000	90
B4	200	90	2 000	0
B5	200	20	2 000	110
C1	250	45	2 500	135

Appendix 2. Informal geographic names of survey areas

Block	*Typical informal name*
A1	Lindsay – Walpolla – Darling Anabranch
A2	North Lake Victoria
B1	Nangiloc – Colignan
B2	Liparoo – Robinvale
B3	Robinvale – Boundary Bend
B4	Boundary Bend – Nyah
B5	Speewa
C1	Barr Creek – Gunbower