Australian Government
Geoscience Australia

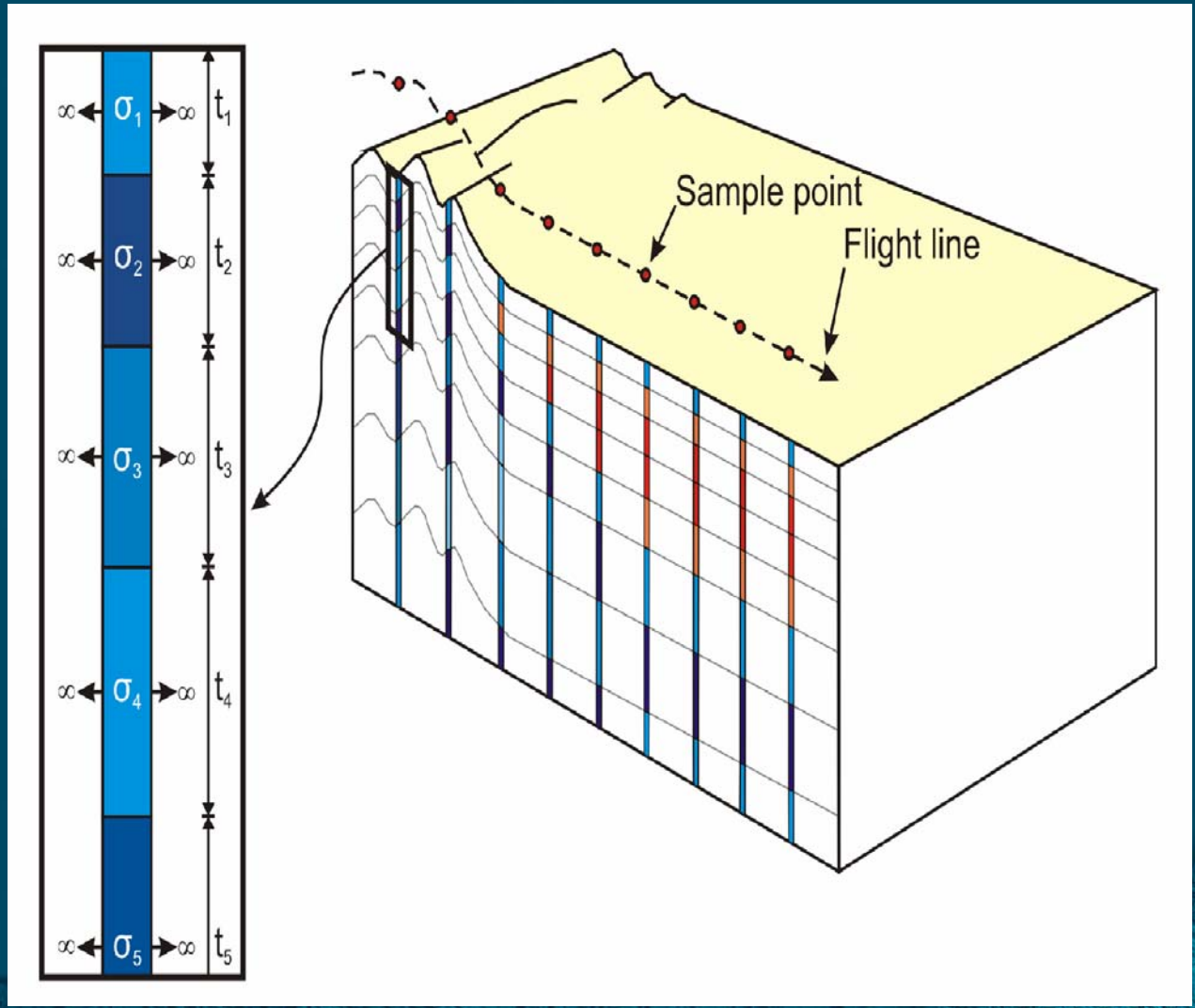
AEM Go Map
Paterson Region, WA

D.K. Hutchinson, M.T. Costelloe, I.C. Roach

GA Layered Earth Inversion

- 30-layer sample-by-sample inversion
- Inversion starts from a homogeneous reference model
- Algorithm iteratively adjusts conductivity values to fit the observed data
- Non-unique solution – where inversion is ambiguous the results tend towards reference model

Sample-by-Sample Inversion



Depth of Investigation (DOI)

- Reliable depth of penetration of AEM signal
- Percent data influence (PDI):
  (Oldenburg and Li, 1999)

$$PDI = 100\left(1 - \frac{\log(\sigma_{i1}) - \log(\sigma_{i2})}{\log(\sigma_{r1}) - \log(\sigma_{r2})}\right)$$

- if PDI > 50%, the inversion is data-driven,
  if PDI < 50%, the inversion is model-driven
- Depth of Investigation (DOI) is the depth at which PDI = 50%

Computing DOI Threshold

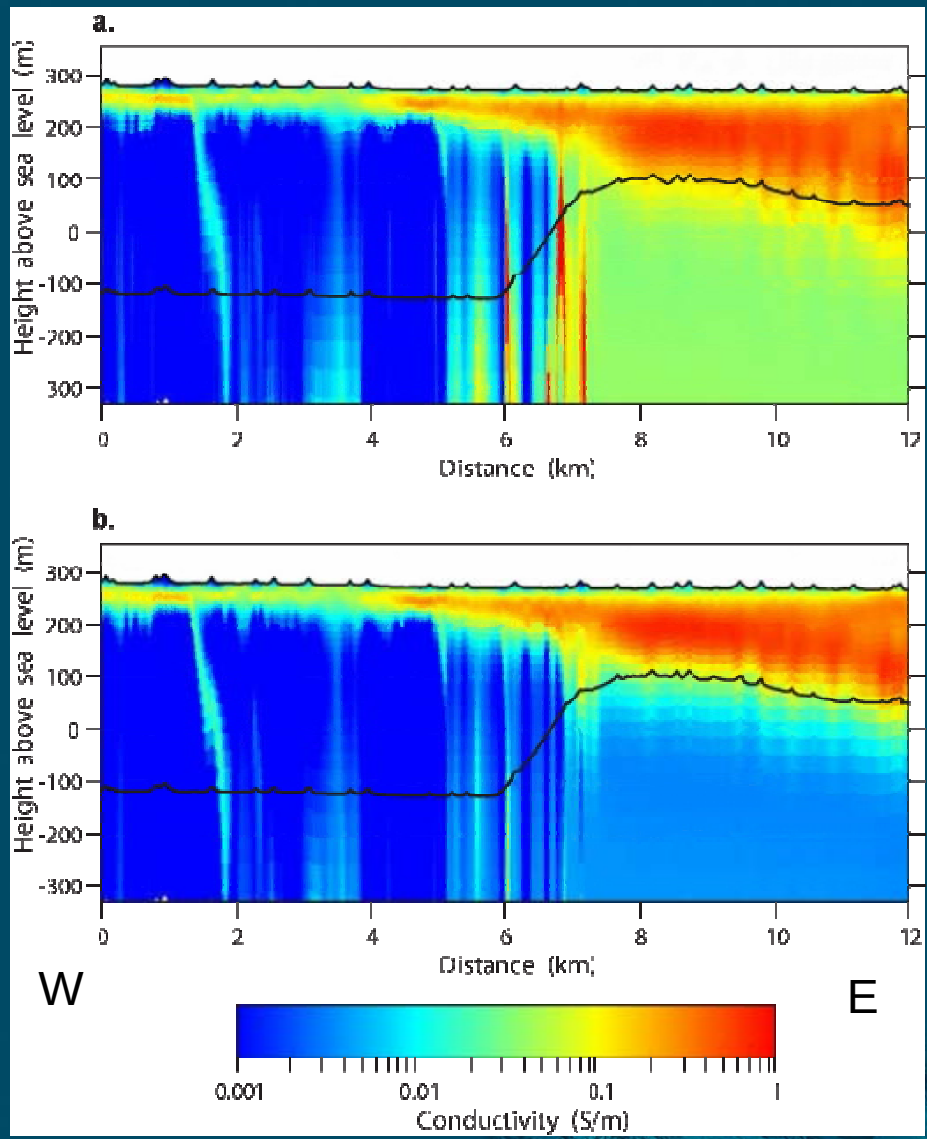
- Compare the results of two inversions, with different reference models

- Reference conductivities:
  (a) 0.04 S/m
  (b) 0.004 S/m

- DOI line represents the 50% threshold between data driven and model driven inversion results

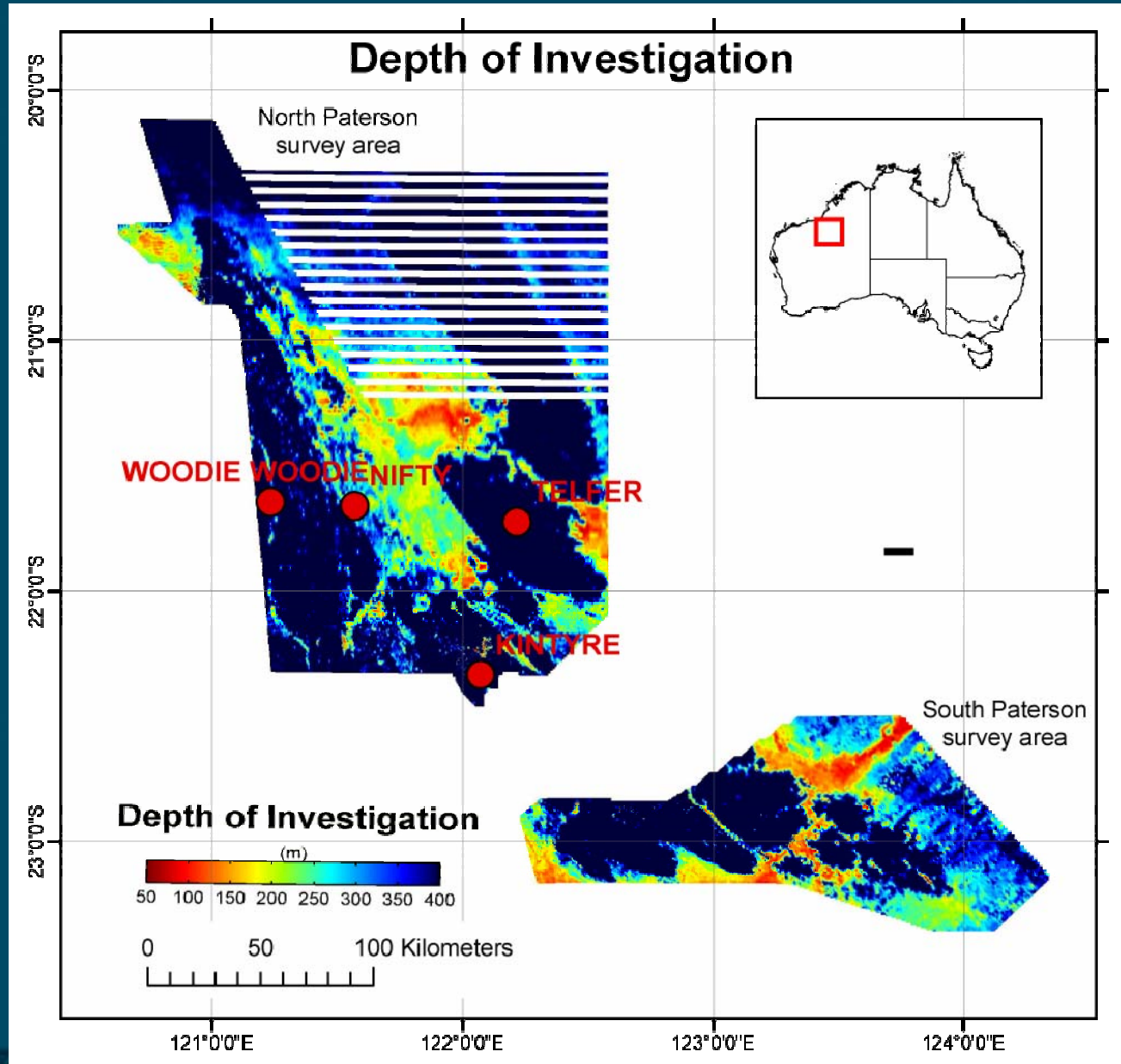
- Below the DOI, the solution tends towards the reference model value

- DOI is capped at 400 m depth



AEM Go Map

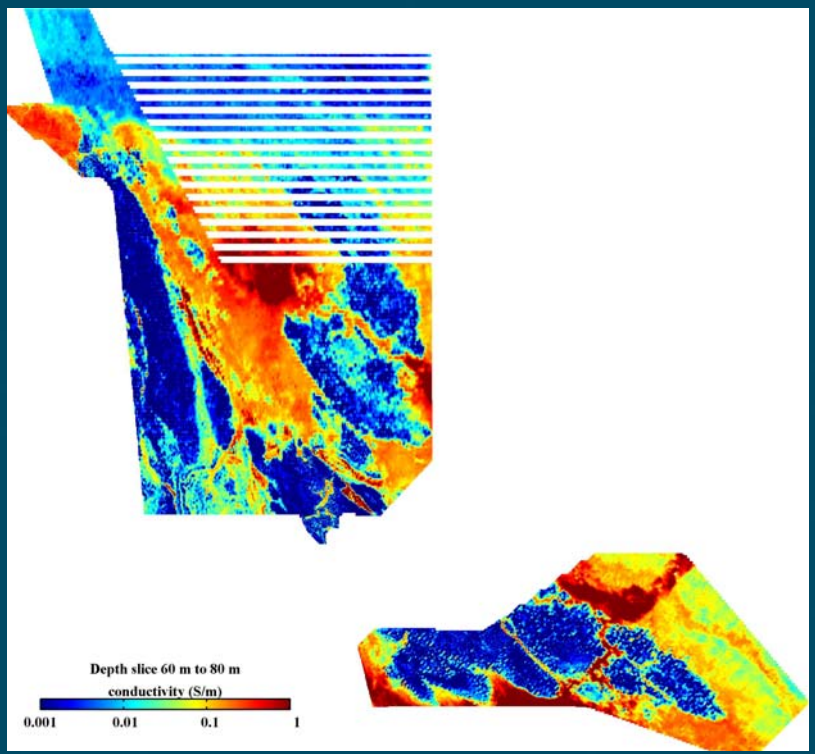
- Maps depth of investigation across survey area
- Reduces exploration risk
- Conductive - shallow
  Resistive - deep



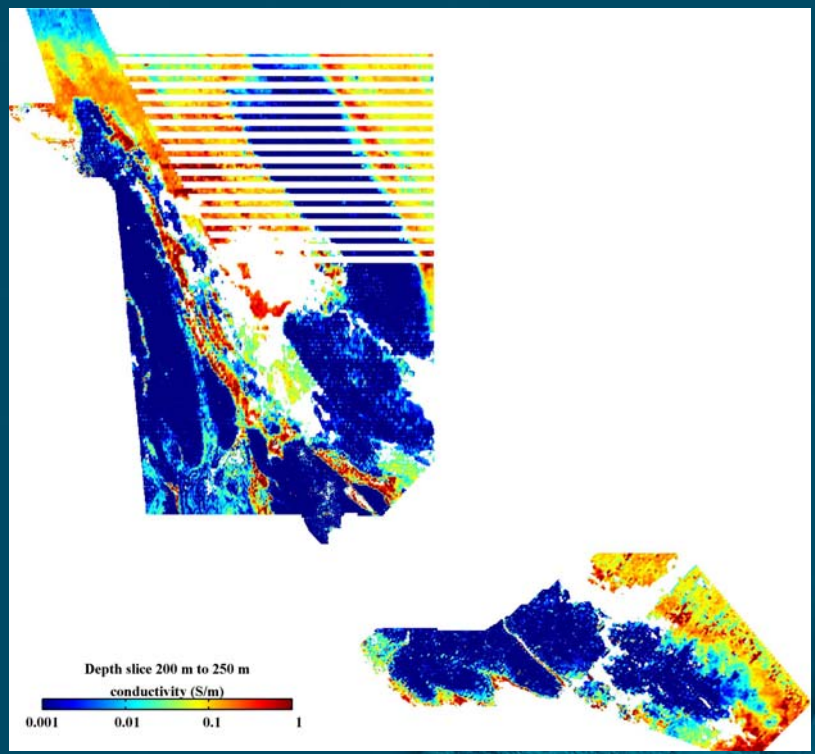
Grid Products

- Data falling below the DOI is masked out

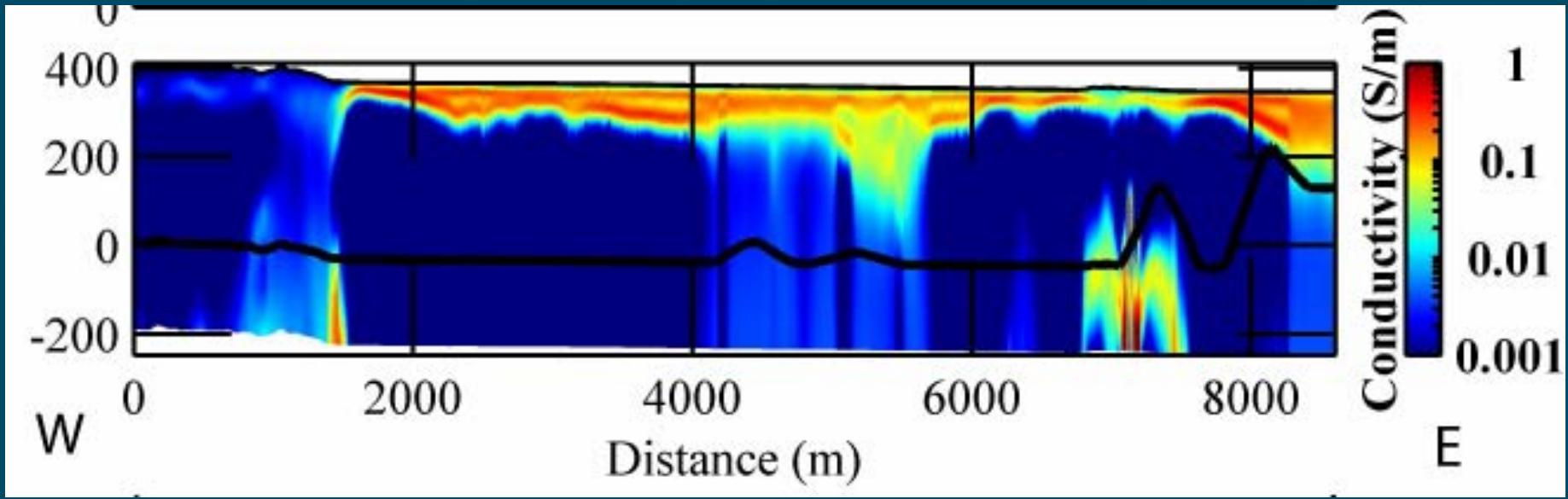
30-40 m Depth slice



200-250 m Depth Slice



Line Sections



- Line sections are produced with a Depth of Investigation line – no masking
- In areas of high noise or 3D geology, individuals can make their own interpretation

Implications

- AEM Go Map shows where EM surveys are likely to be effective
- Reduces exploration risk due to highly variable depth penetration
- Prevents false interpretations from model-driven inversion results.

Preview April 2010

Depth of investigation grid for regional AEM surveys

Feature Paper

Depth of investigation grid for regional airborne electromagnetic surveys

David Hutchinson

David K. Hutchinson[1,2], Ian C. Roach[1] and Marina T. Costelloe[1]

[1]*Airborne EM Group, Onshore Energy and Minerals Division, Geoscience, Australia.*
[2]*Corresponding author. Email: david.hutchinson@ga.gov.au*

We describe a new method of presenting the depth of investigation (DOI) for an Airborne Electromagnetic (AEM) Survey of the Paterson region, Western Australia. The DOI is derived using the Geoscience Australia Layered Earth Inversion (GA-LEI) algorithm of Lane *et al*. (2004), which includes conductivity reference model constraints. Thus the inversion is influenced by both subsurface conductivity and reference model assumptions. The DOI is chosen to be the maximum depth to which the inversion is more influenced by data than the model assumptions. A 2D grid of the DOI across the survey area illustrates clearly how the depth penetration of AEM varies across this regional-scale survey. This information about the depth penetration can be used by the mineral exploration industry when planning detailed AEM surveys.

(2007–08), the Pine Creek region of the NT (2009) and the Lake Frome region of SA (planned for 2010). The surveys are funded by the Australian Government's Onshore Energy Security Program, and cover much larger areas than previous AEM surveys flown in Australia. They are designed to provide pre-competitive AEM data on flight lines spaced several km apart. These regional-scale surveys aim to highlight targets for more detailed investigation by the mineral exploration industry. A key point of interest in these surveys is to show where smaller scale AEM surveys could be effective, so that further exploration using AEM (or ground-based EM) surveys will have reduced risk in locating exploration targets.

Here we present a new method for determining and imaging the depth of penetration of the AEM technique. A map of the depth of investigation (DOI) of the Paterson survey is presented. This DOI map provides a new means of visually determining the utility of the AEM method based on regional data and will be applied to future regional surveys to help determine the likely effectiveness of more detailed investigations.

Determining the depth of investigation

The data presented here have been inverted from airborne measurements to form a conductivity depth model using the GA Layered Earth Inversion (GA-LEI) algorithm of Lane *et al.* (2004). This algorithm uses an assumed conductivity reference model as a starting point and iteratively adjusts the model until the measured AEM data are fitted. Since the inversion solution is non-unique, a reference model is used to constrain the solution. Note that the reference model used in this study is a half-space of uniform conductivity. Where the model is unresolved (or ambiguous) the solution will tend toward the reference model.