Fast-sampling EM applied to the River Murray and surrounding floodplains in Australia

Michael Hatch[1], Volmer Berens[2], Andrew Fitzpatrick[3], Graham Heinson[1], Tim Munday[3], Andrew Telfer[4]

[1]CRCLEME, School of Earth and Environmental Sciences, University of Adelaide, Adelaide SA, Australia

[2]South Australian Department of Water, Land, and Biodiversity Conservation, Adelaide SA , Australia

[3]CSIRO Exploration and Mining / CRCLEME, Technology Park, Kensington WA , Australia

[4]Australian Water Environments, Norwood SA , Australia

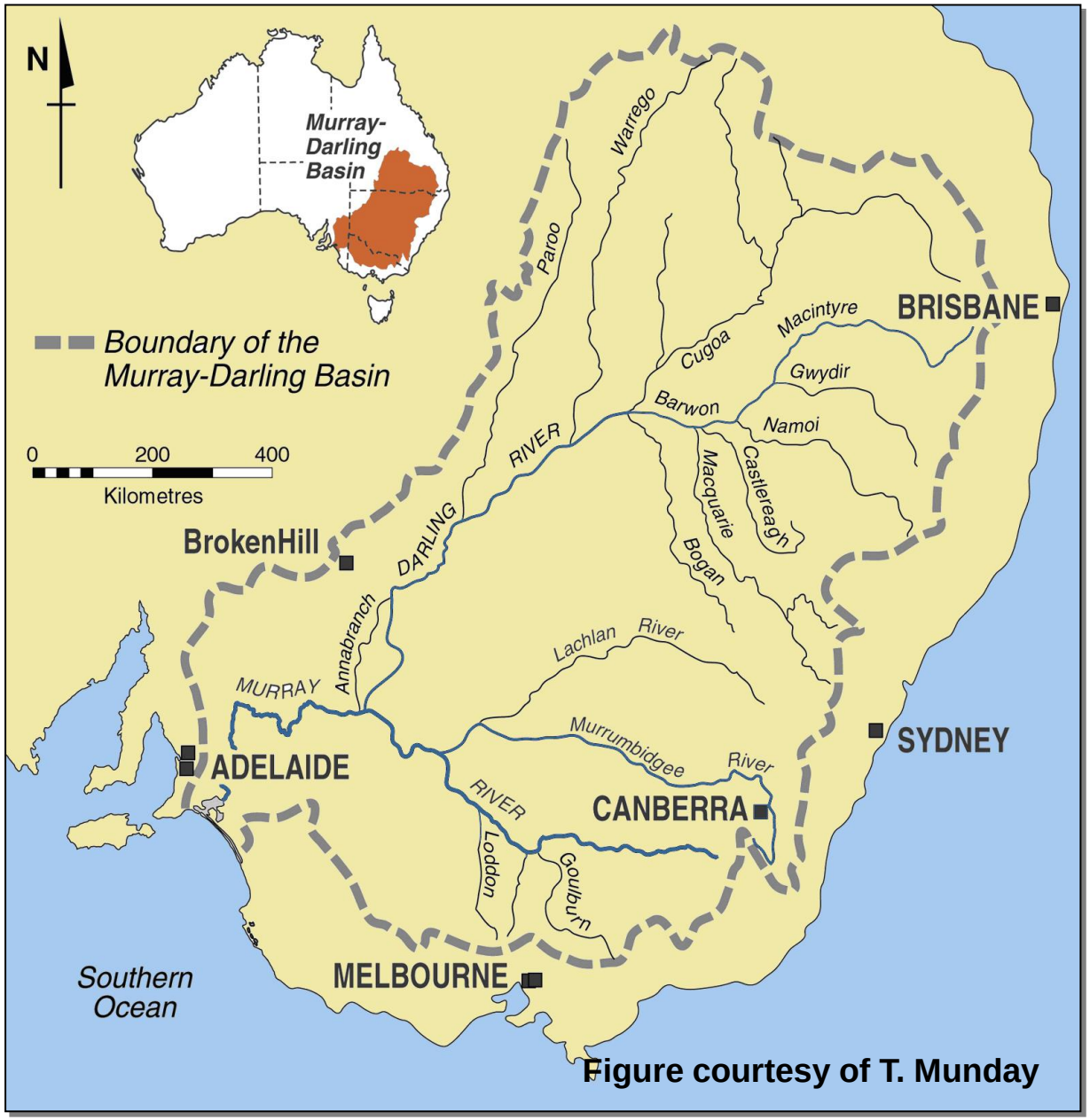
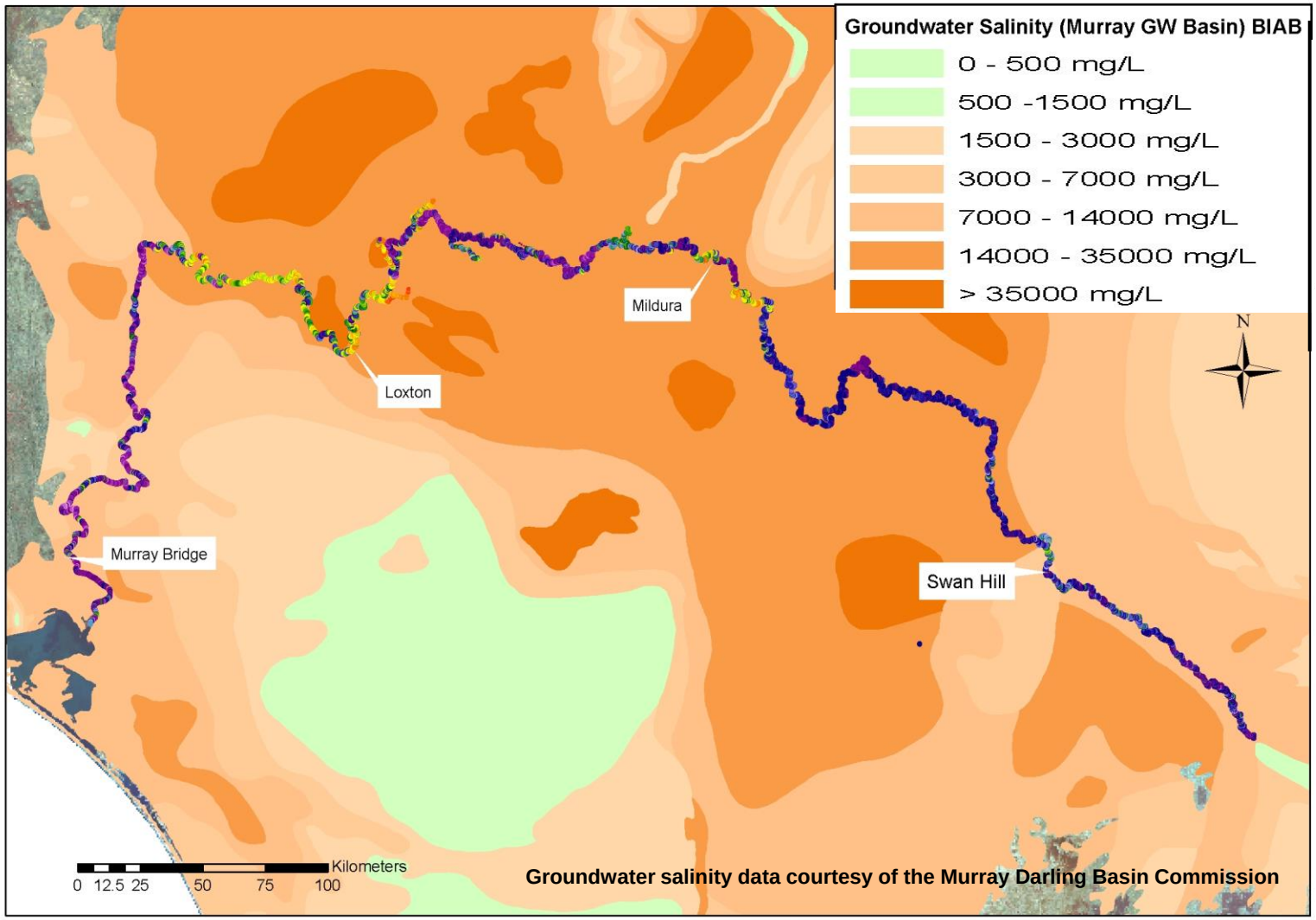


Figure courtesy of T. Munday

Fast sampling EM: Where were these data collected?

WHAT ARE THE GEOHYDROLOGICAL ISSUES IN THE MURRAY BASIN

(that I am interested in)?



Ocean water is about 28,000 mg/l or 5000 mS/m or 0.2 ohm-m

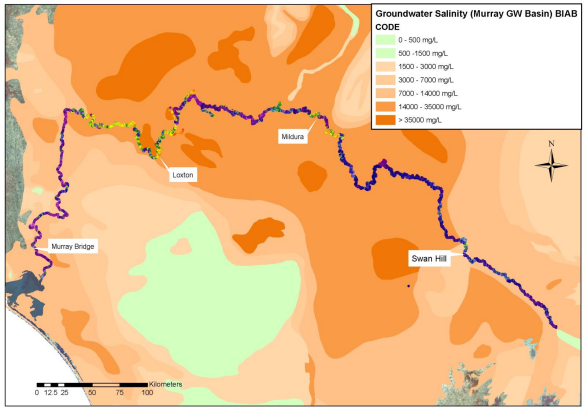
WHAT ARE THE GEOHYDROLOGICAL ISSUES IN THE MURRAY BASIN

(that I am interested in)?

- Most of the basin is underlain by highly saline groundwater (>25,000 EC). Sea water is >50,000 EC.
- This groundwater is quite shallow, and therefore quite close to the river and floodplains.
- Historically parts of the river have gained saline groundwater.
- This process has been exacerbated by over-irrigation near the river which tends to push the underlying groundwater to the floodplain and then to the river more quickly.

WHAT IS HAPPENING ON THE FLOODPLAIN?

- Floodplain processes are important to river salinity and health. We need more tools to help characterise floodplain health.
- Floodplains vary in width from tens of metres to kilometres and run along most of the river.
- Access can be difficult and floodplains are often covered in scrub. Airborne techniques will mos likely provide the most complete coverage. For now...



WHY DO GEOPHYSICS IN THIS ENVIRONMENT?

- Too much salt in the river is bad. And salty, conductive water is a good target for shallow geophysical techniques.
- Older technologies were good for finding large salt infiltrations, but we need to locate smaller sources.
- We need to characterise the floodplains.

Geology of the Murray Basin at Loxton (a typical section along the river)

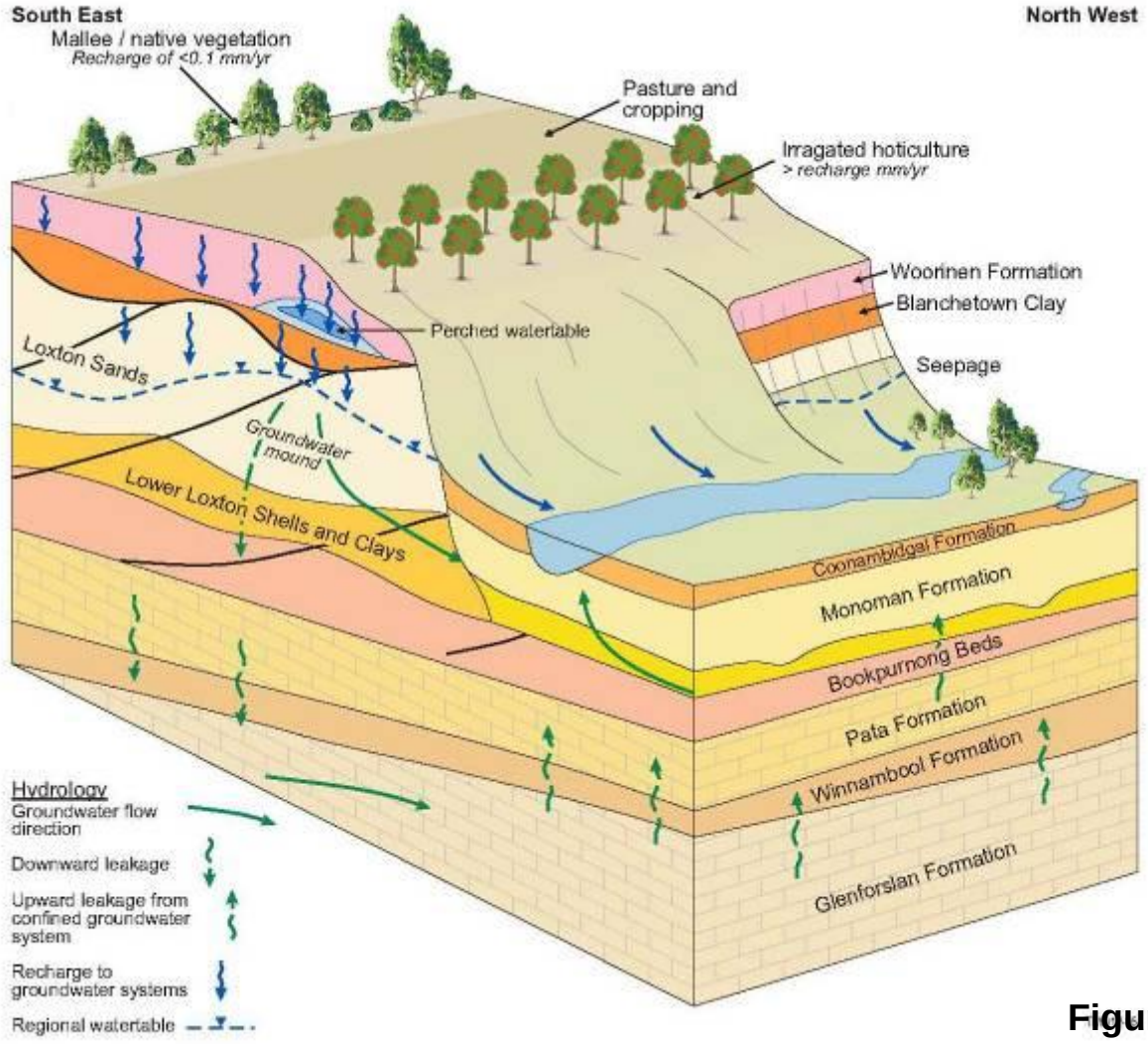
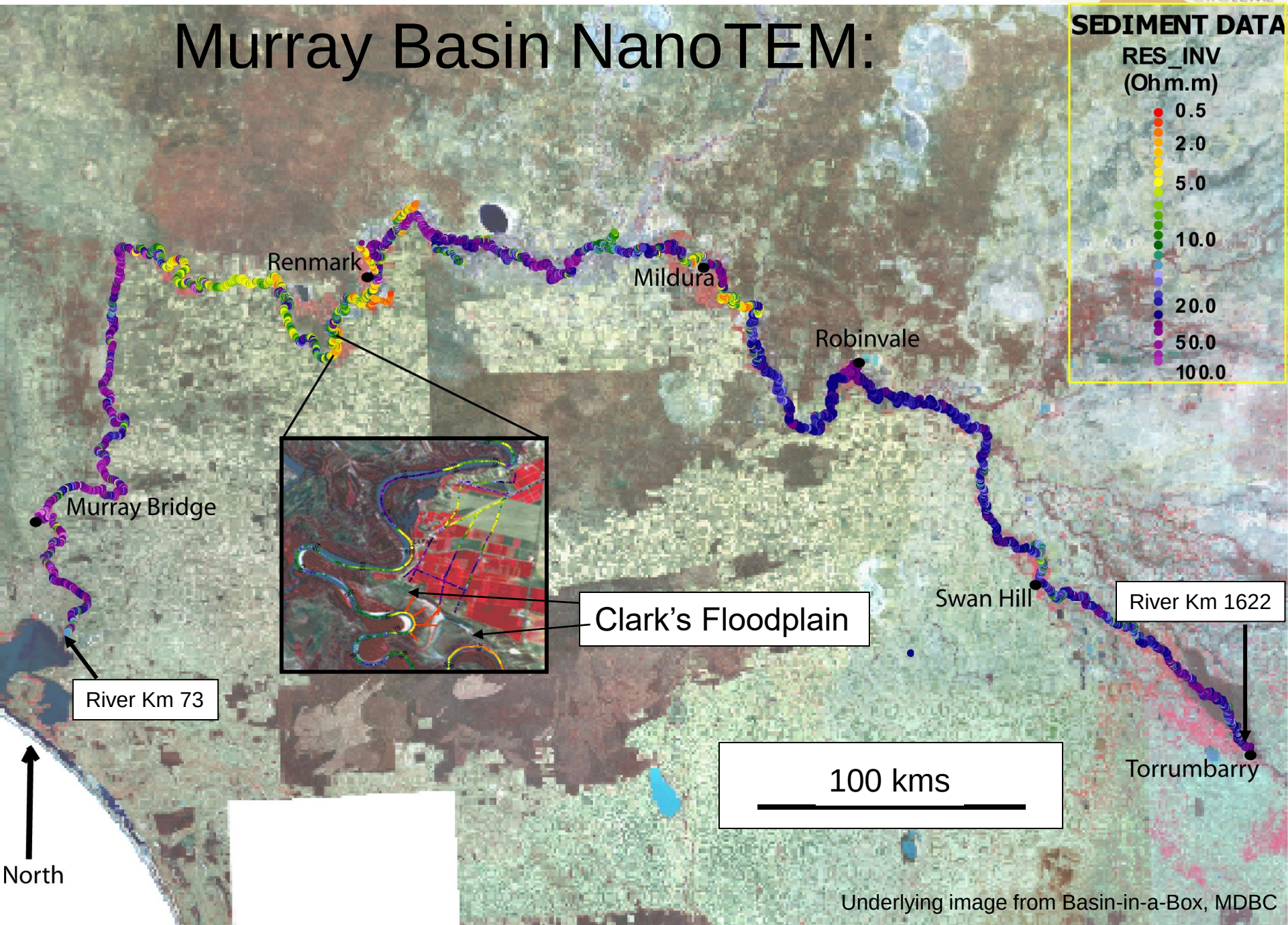


Figure courtesy of T. Munday

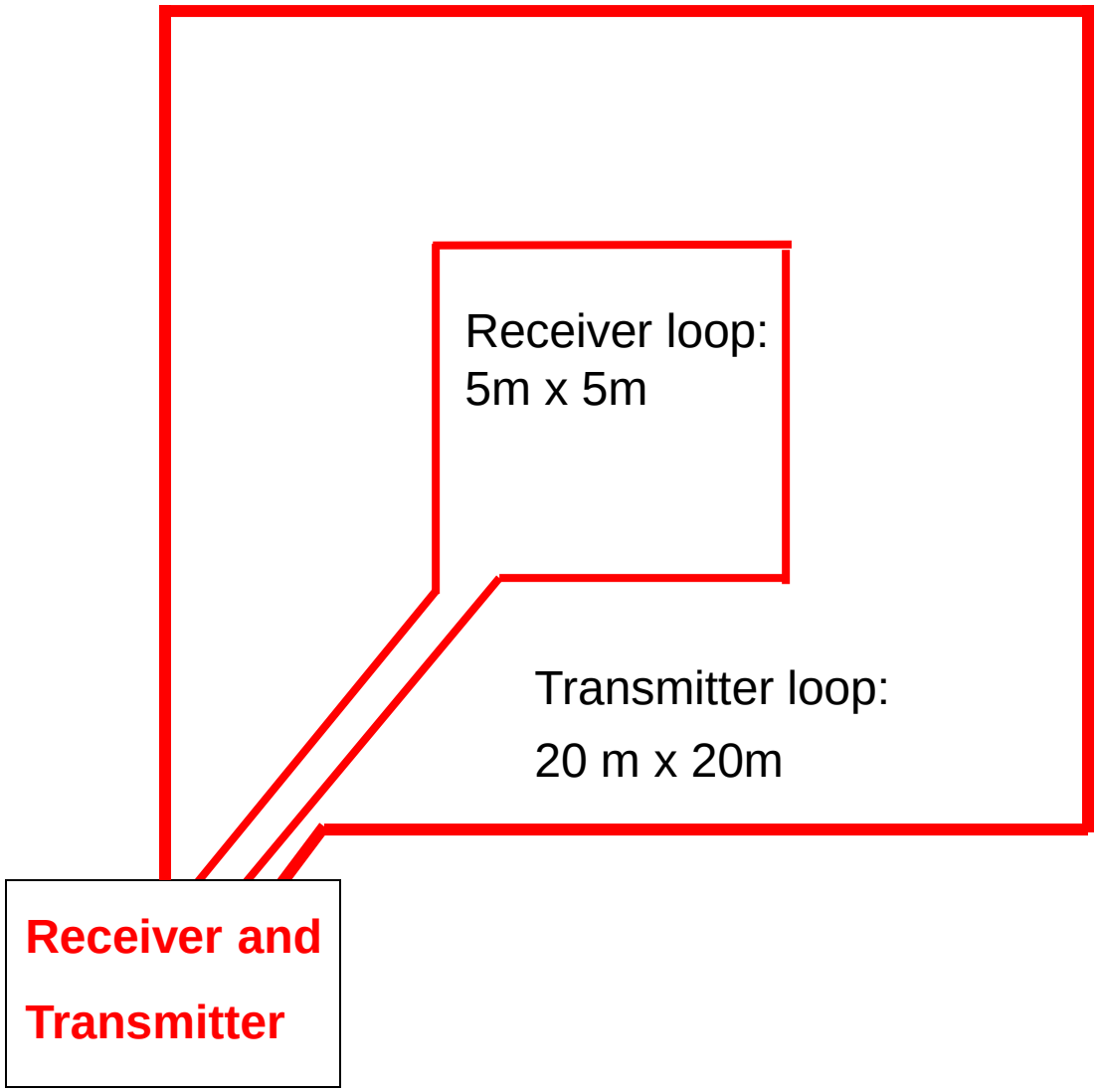
Murray Basin NanoTEM:



“Standard” NanoTEM

“Normal”
NanoTEM Setup

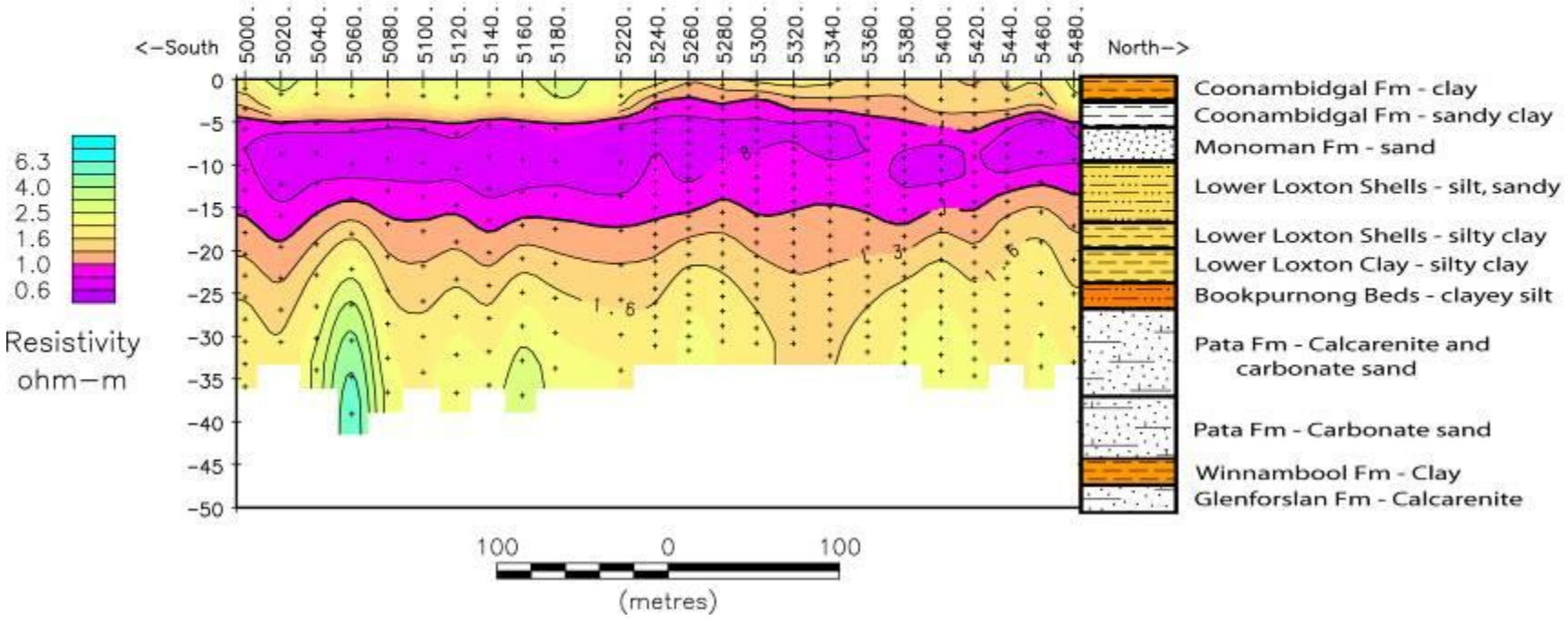
- **Transmitter shuts off in <2 microseconds.**
- **Receiver turns on in <2 microseconds.**
- **Receiver sampling rate can be set to 1.6 or 1.2 microseconds.**



“Standard” NanoTEM on Clark’s Floodplain

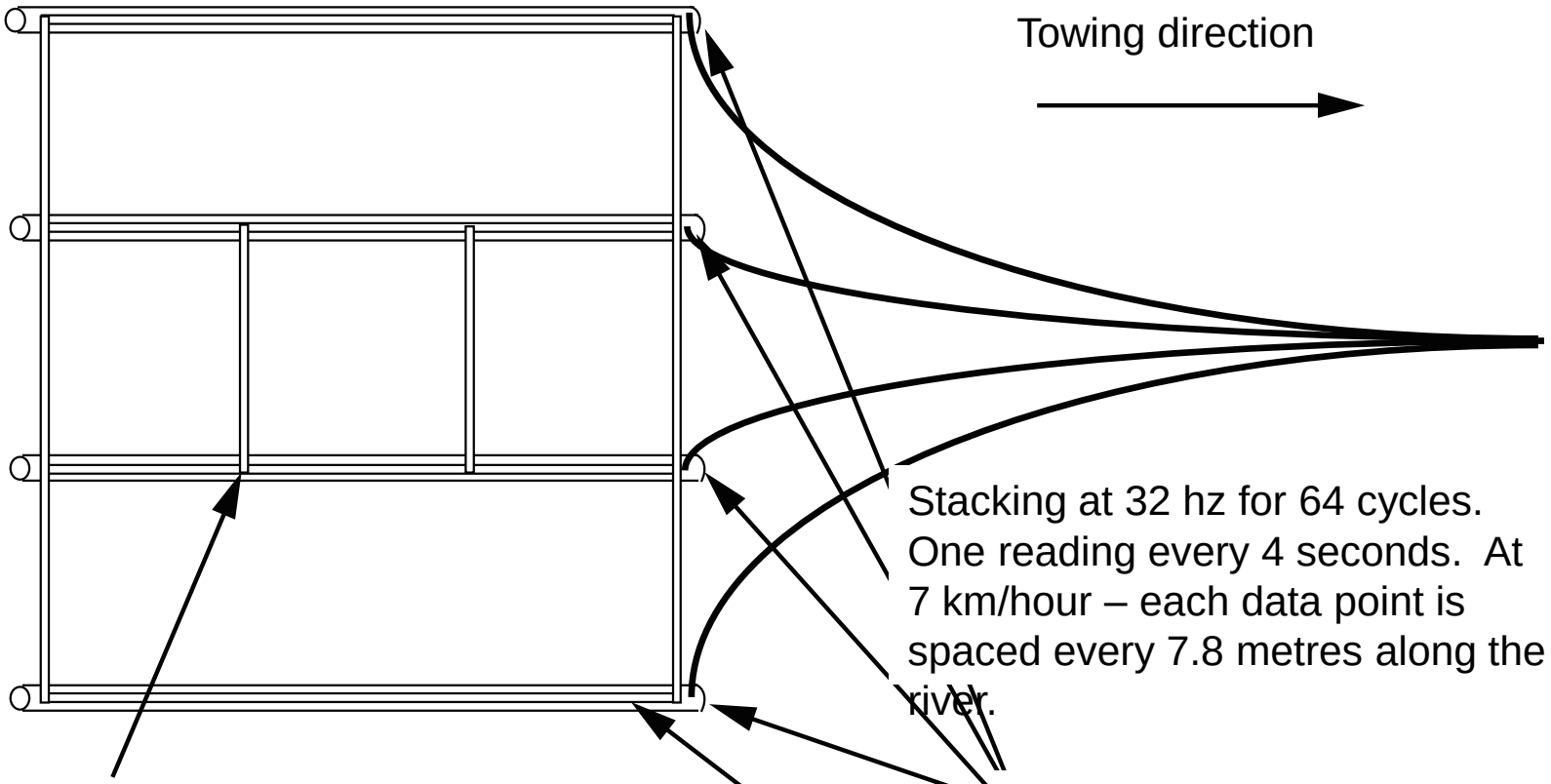
Cooperative Research Centre for Landscape Environments and Mineral Exploration

Note that near-surface groundwater sampled at bore was 42,100 uS/m ie approximately ¼ ohm-m.



NanoTEM data is courtesy of SA DWLBC
Borelog is courtesy of AWE and Bookpurnong Lock 4 Environmental Association.

Instream NanoTEM



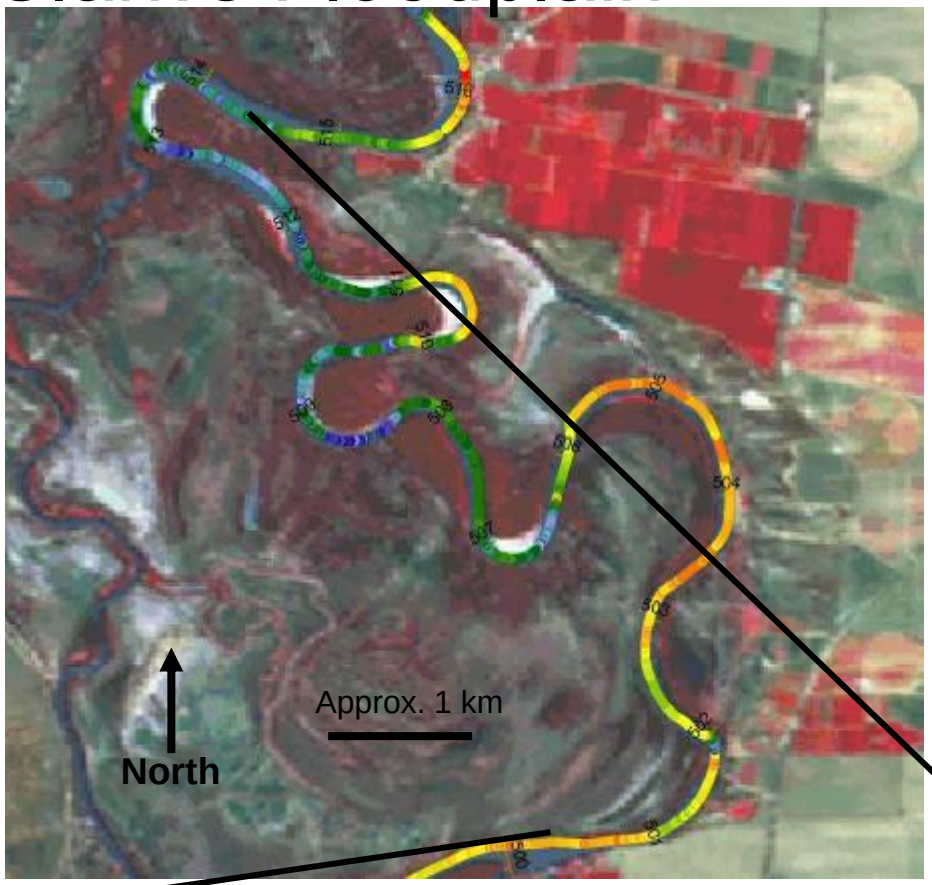
Instream NanoTEM

- Equipment enables collection of large amounts of data, quickly.
- System has been commercialised with almost 2000 line km collected so far.
- Each survey as stand-alone has provided lots of new information about the river. We are in the process of evaluating value of repeat surveys.

Thanks to Barry Porter, SA DWLBC

Instream NanoTEM: 2006

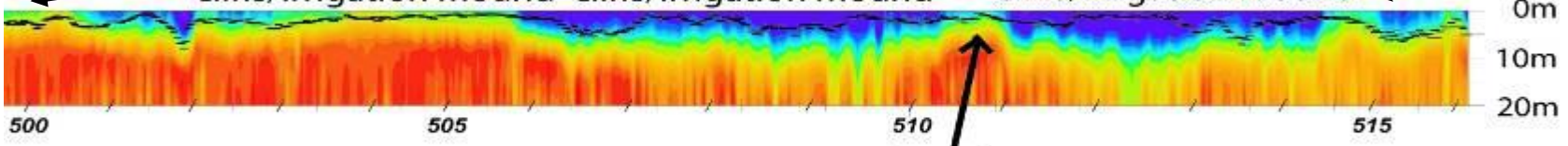
Instream NanoTEM at Clark's Floodplain



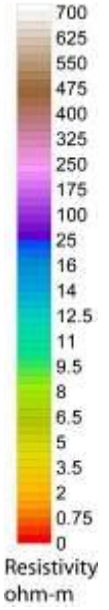
river close to cliffs/irrigation mound

river distant from cliffs/irrigation mound

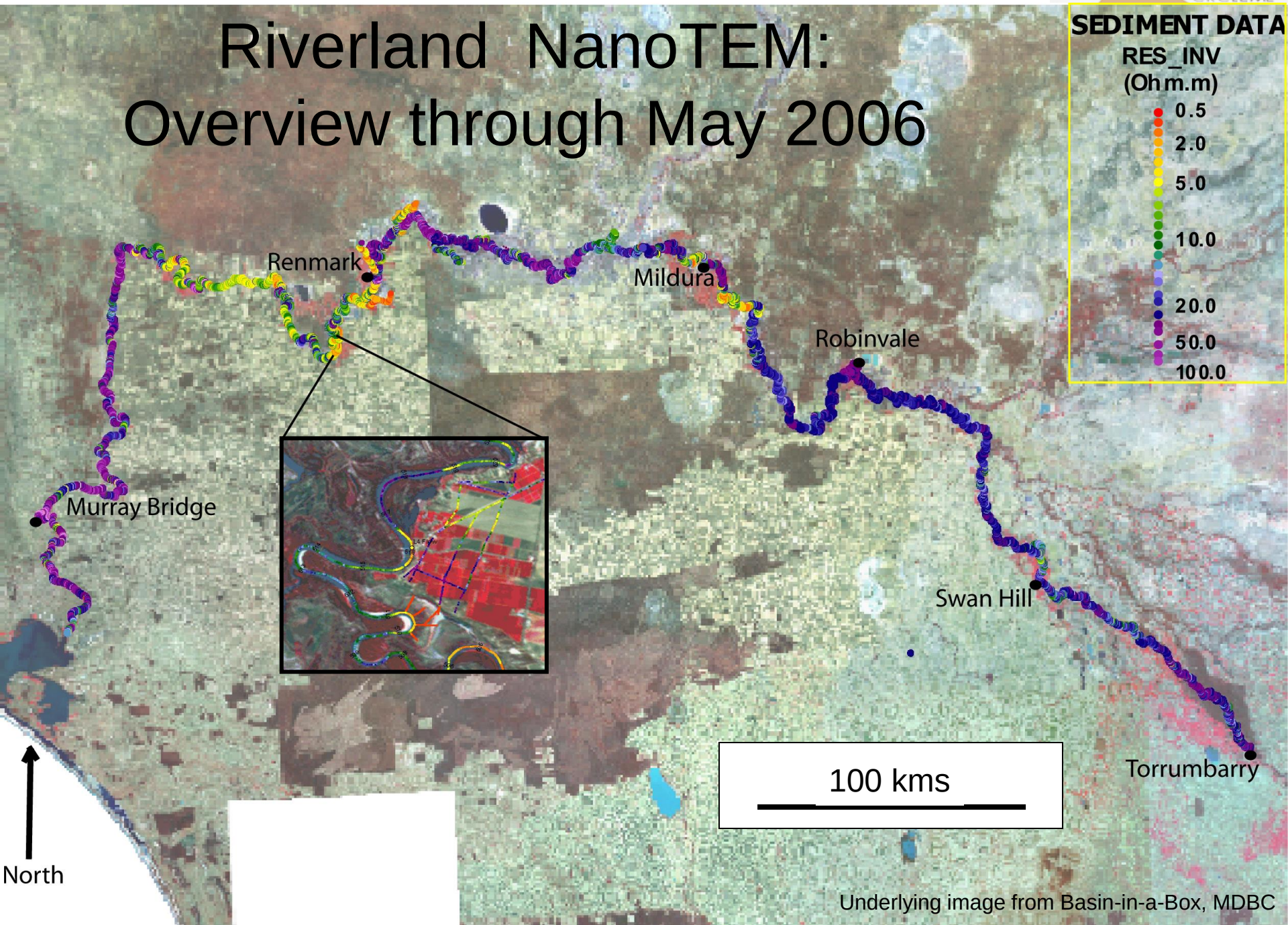
river distant from cliffs/irrigation mound



river close to cliffs/irrigation mound

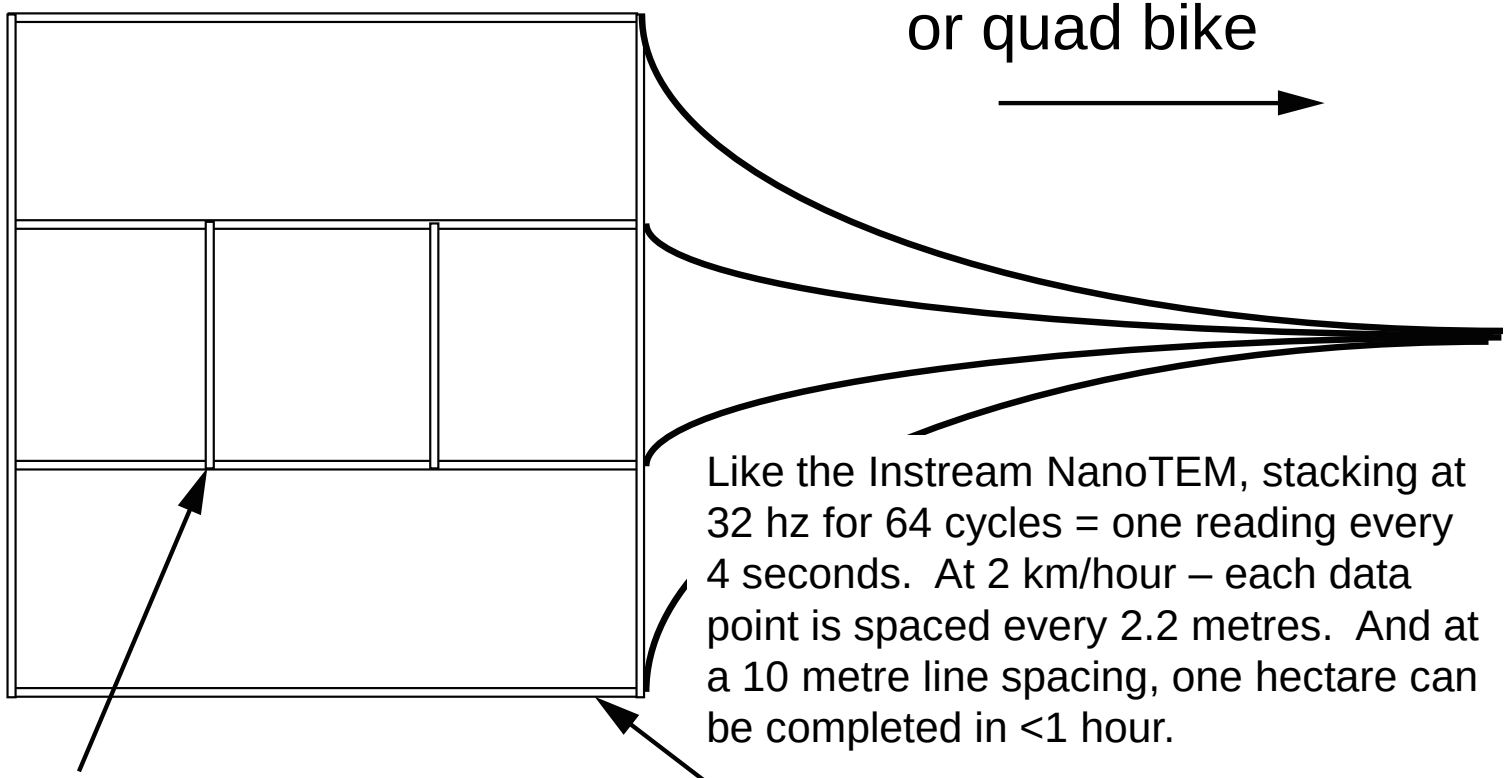


Riverland NanoTEM: Overview through May 2006



Towed frame development

Towed behind truck
or quad bike



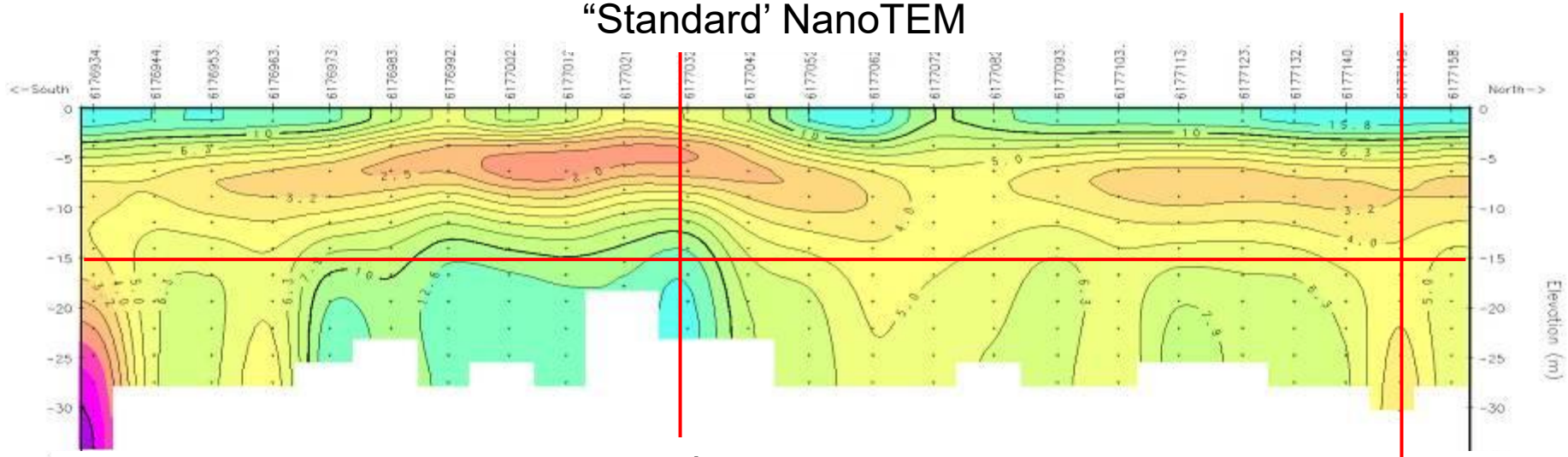
Like the Instream NanoTEM, stacking at 32 hz for 64 cycles = one reading every 4 seconds. At 2 km/hour – each data point is spaced every 2.2 metres. And at a 10 metre line spacing, one hectare can be completed in <1 hour.

1m x 1m central receiving antenna.
Made up of three turns of wire.

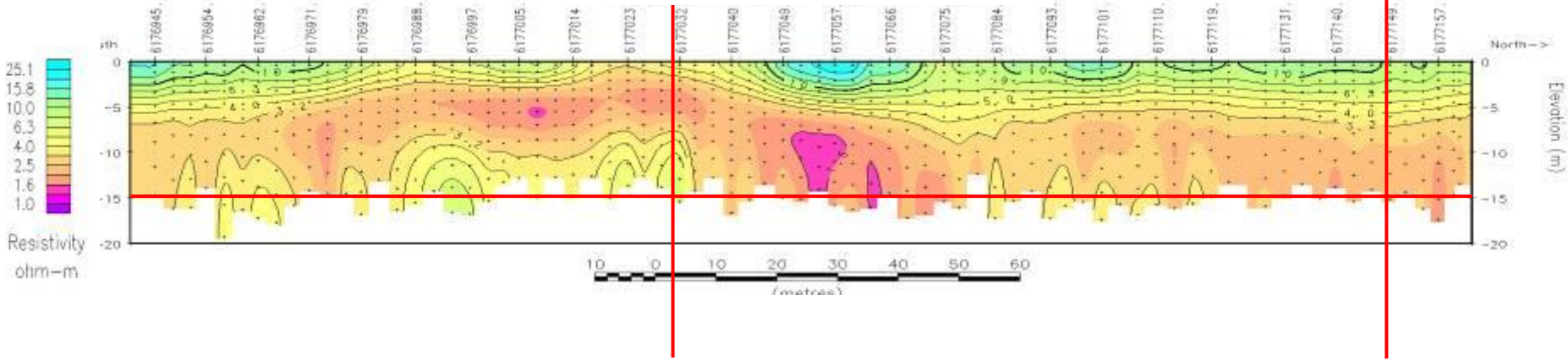
3m x 3m transmitting antenna
on outside of frame. Made up of
three turns of wire.

Towed frame: Test Line at University of Adelaide campus

“Standard’ NanoTEM

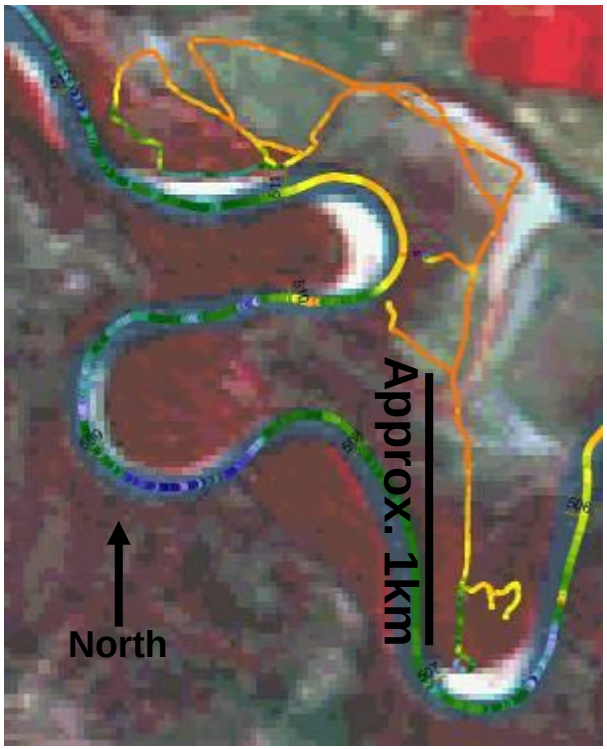


Towed NanoTEM



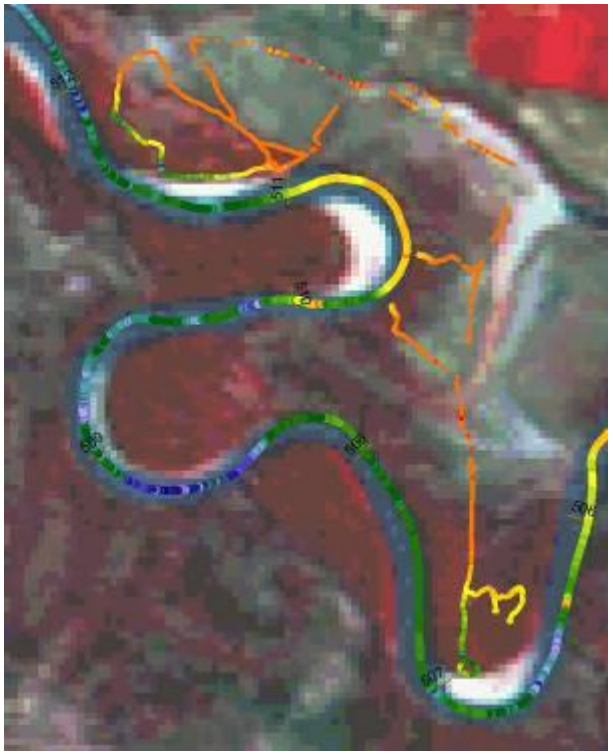
Towed frame: Overview of an afternoon's data collection at Clark's Floodplain

Towed frame: Overview of an afternoon's data collection at Clark's Floodplain



Depth slice at 2m

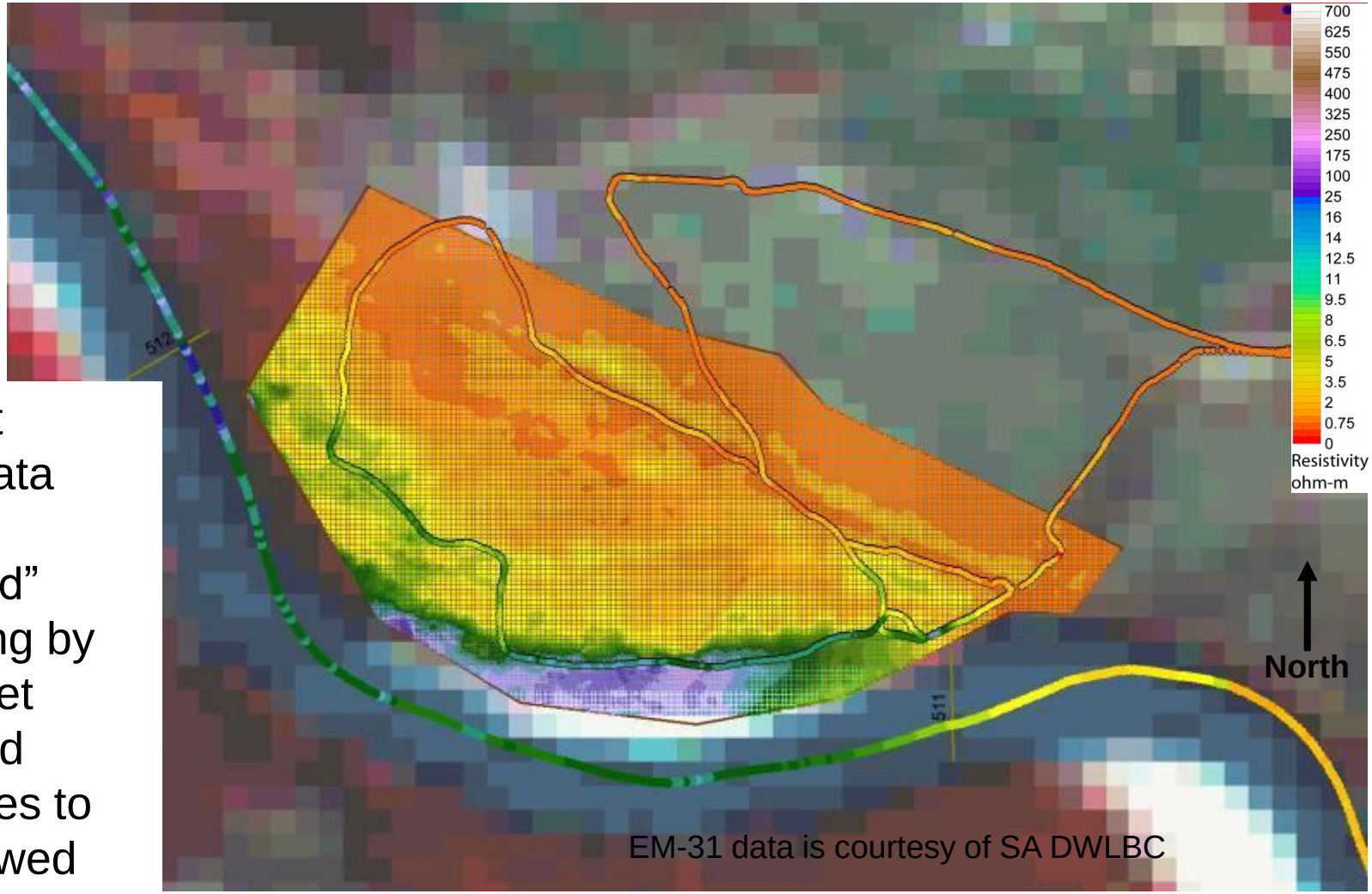
Depth slice at 6m



Depth slice at 10m

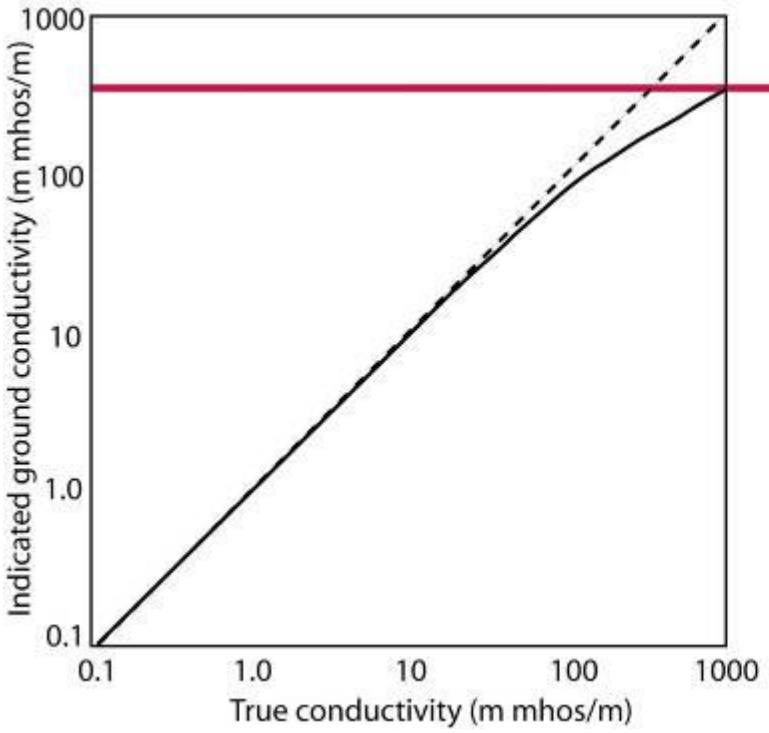
Towed frame:

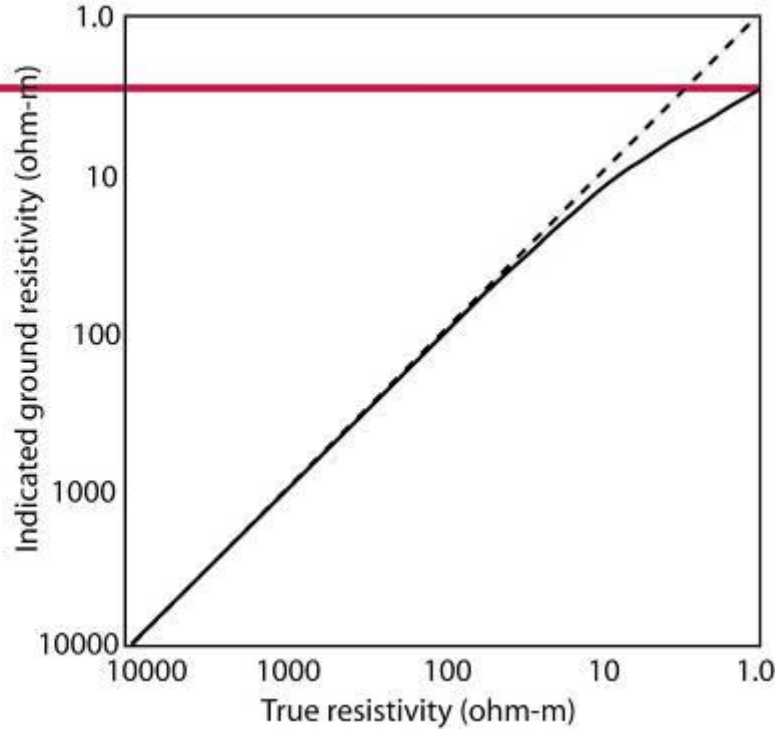
Comparison with EM-31 at Clark's Floodplain: Area A



Note that EM-31 data were "corrected" by dividing by 2.65 to get calculated resistivities to match towed NanoTEM data

Towed frame: Comparison with EM-31 at Clark's Floodplain: Area A



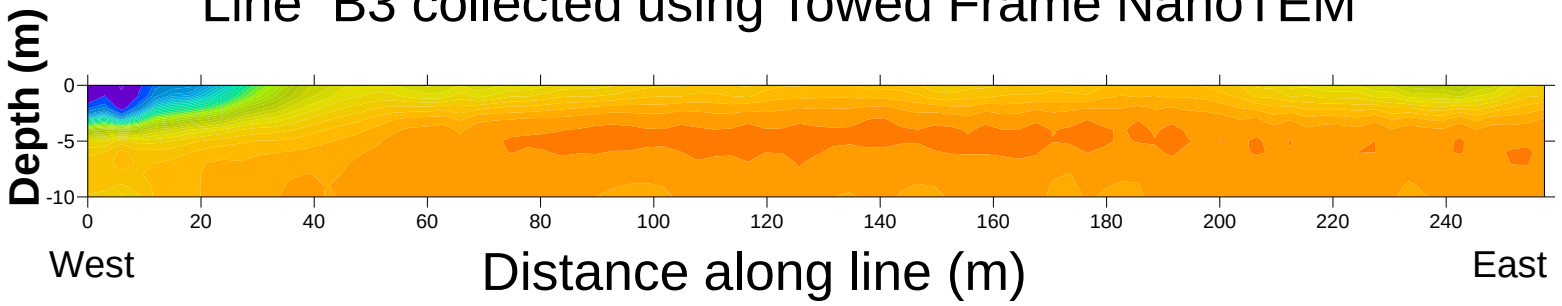


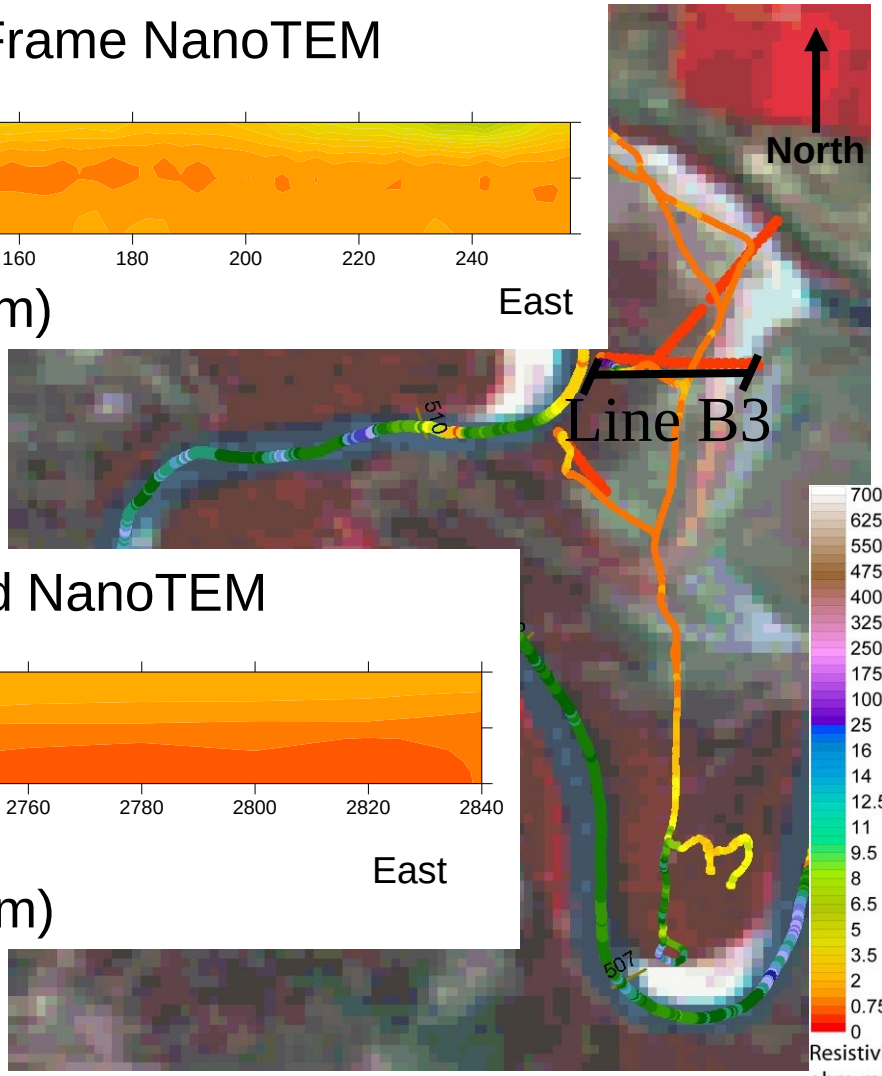
On the EM-31 a true resistivity of 1 ohm-m is read on the instrument as at least 2 ohm-m.

Figure modified from Geonics Technical Note TN-6

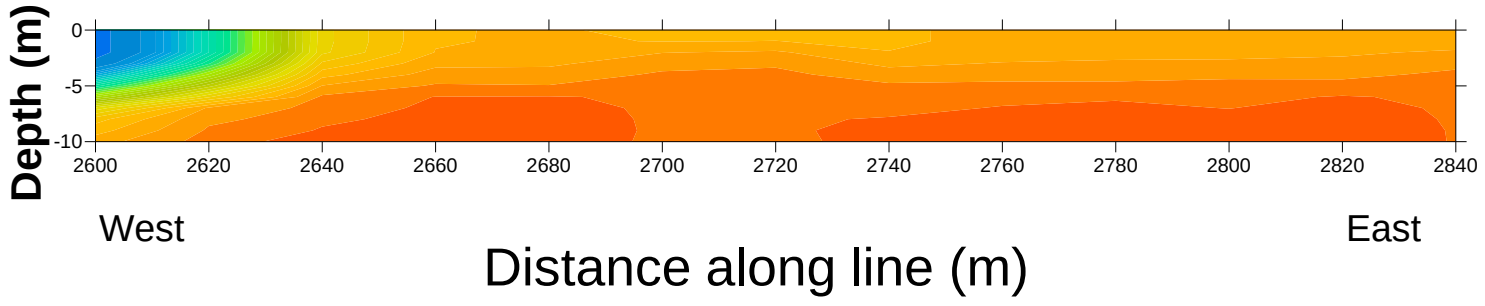
Towed frame: at Clark's Floodplain: Area B

Line B3 collected using Towed Frame NanoTEM

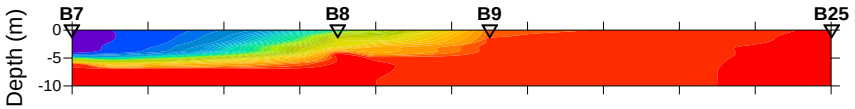




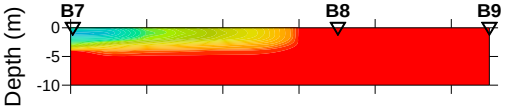
Line B3 collected using standard NanoTEM



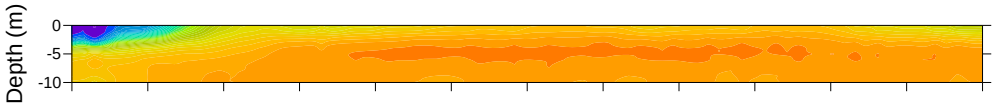
Towed frame: at Clark's Floodplain: Area B



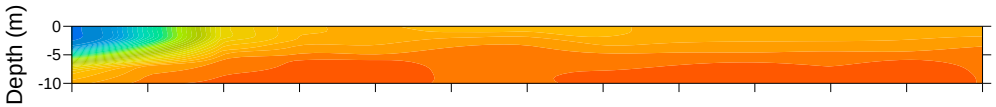
Groundwater EC
January 2007



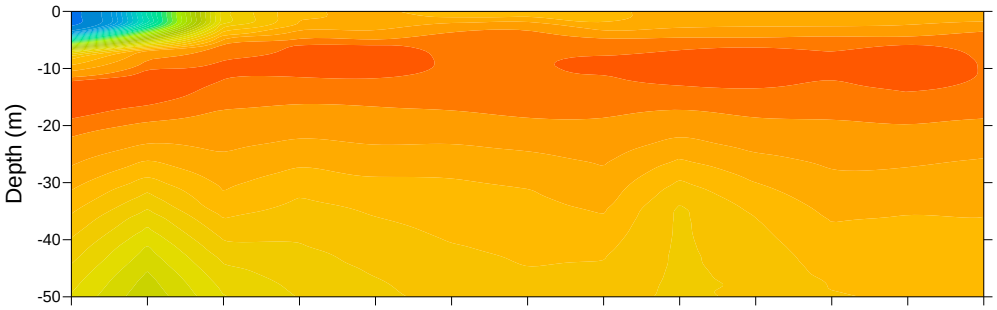
Groundwater EC
January 2006



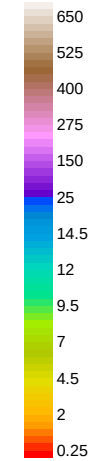
Sled NanoTEM
July 2006



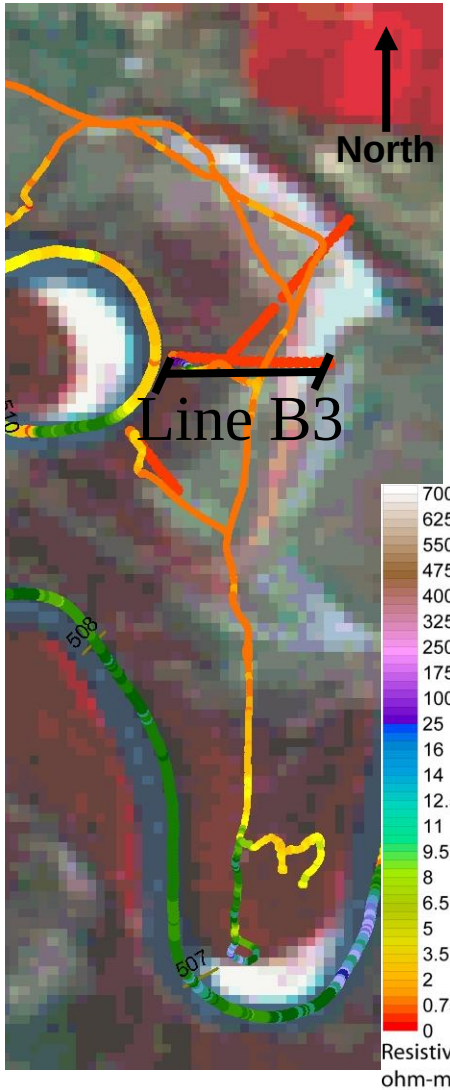
Static NanoTEM
November 2005



Static NanoTEM
November 2005



Resistivity
ohm-m



Resistivity
ohm-m

Conclusions

- Fast-sampling shallow TEM is shown to be an important tool in the characterisation of river and floodplain systems. These data sets add high resolution information about salinity and geological variation.
- Development of a system to rapidly look at the top 10 metres of a floodplain (or a farm paddock or…) is a worthwhile extension of the “Standard” NanoTEM system.

ACKNOWLEDGEMENTS

- Murray Darling Basin Commission
- Mid Murray LAP
- SA DWLBC
- NSW DIPNR
- Mallee Catchment Management Authority
- Goulburn Murray Water
- Mid Murray LAP
- North Central Catchment Management Authority
- NSW DIPNR
- Australian Water Environments
- CRCLEME (including GA and CSIRO)
- Zonge Engineering (Australia)
- Brian Barrett (presently at University of Leeds)
- Barry Porter (SA DWLBC, Berri, SA)
- Geophysical Resources and Services (GRS)