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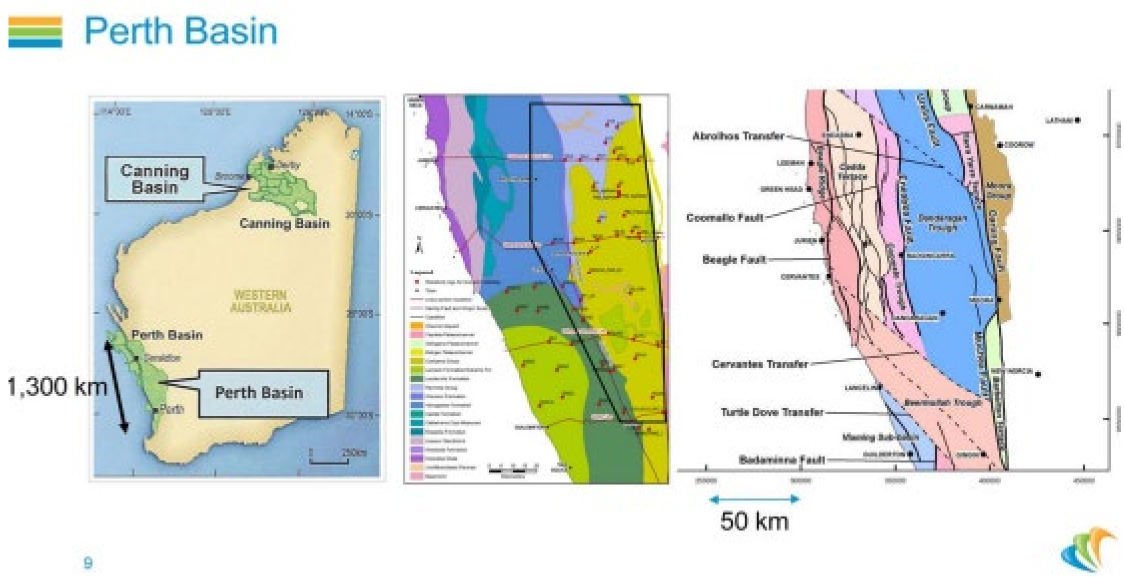
SMART MAPPING

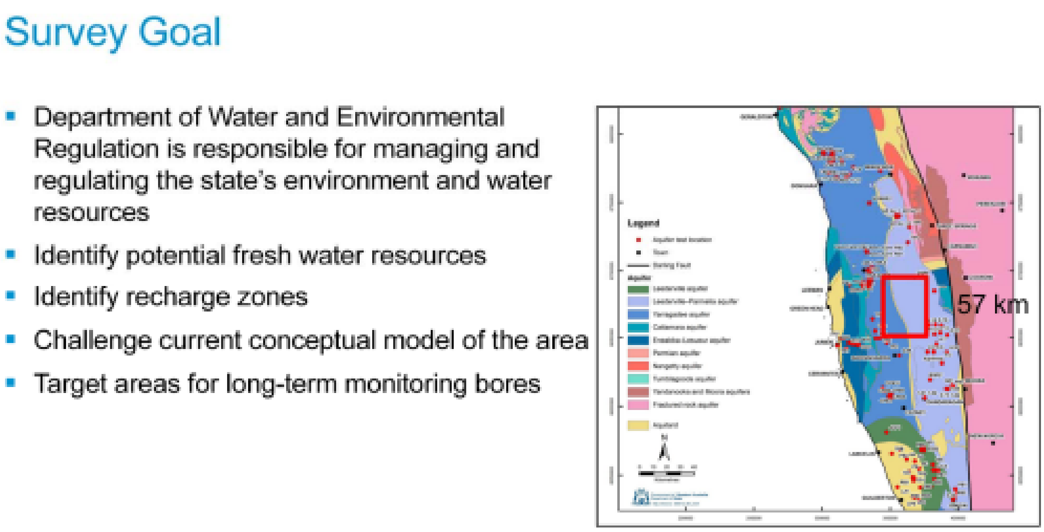
Water Detection Solution

Xcalibur Smart Mapping

Acquifer delineation using the TEMPEST AEM System

The Perth Basin is a large north to north-northwest trending, onshore and offshore sedimentary basin extending about 1300 km, 800 miles (172,000 sq km, 66,000 sq miles, same as Florida; Tennessee is 45,000 sq miles) along the southwestern margin of Australia. This basin formed during multiple episodes of rifting between Australia and Greater India from the early Permian to the Early Cretaceous. Extension during the Permian produced a series of deep, north-south trending rift basins along the western margin of the Yilgarn Craton. This was followed by marine sediment deposition, then Late Permian uplift and erosion. Sediments in the basin are up to 12 km thick.

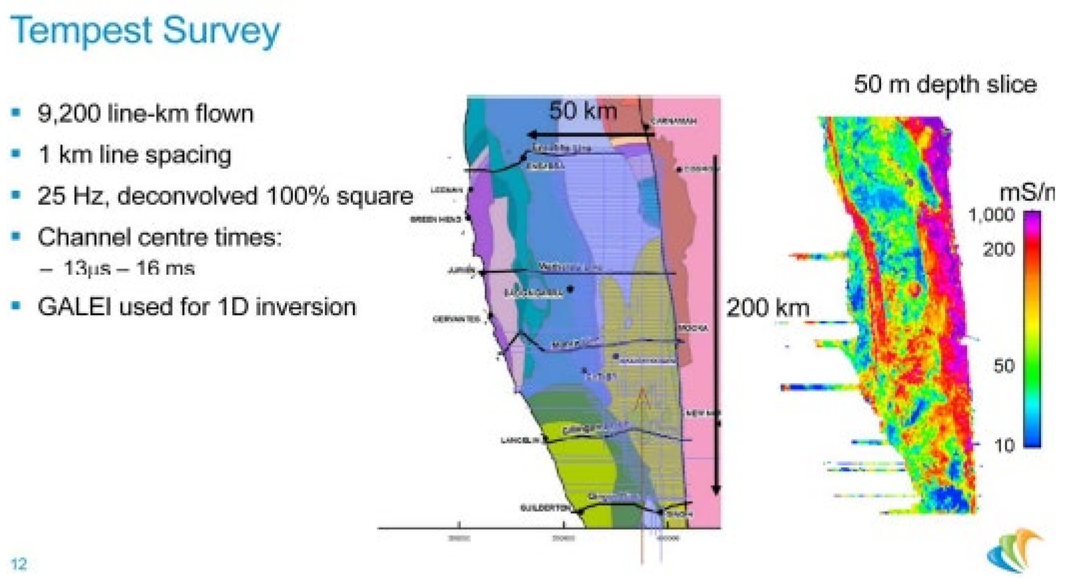




The Tempest fixed-wing Time domain system was used on the survey. Line spacing was 1km, giving a survey size of 9,200 km. The flight lines were very long, up to 90 km. The system provides data convolved to a

100% duty cycle square wave, with channel center times from 13 microseconds to 16 ms. We then used the 1D sample-by-sample smooth- model inversion code GALEI.

The flight lines superimposed on the geology map are shown in the left figure, and the 50 m conductivity depth slice on the right.



REFERENCES

Case Study – Perth Basin – Department of Water and Environmental Regulation

CGG Multiphysics

Airborne geophysical surveys of the lower Mississippi Valley demonstrate system-scale mapping of subsurface architecture.

Mapping the Mississippi Alluvial Plain -- 2018-2020

Target/goal or objective: To conduct a system-scale airborne geophysical survey over the Mississippi Alluvial Plain (MAP) region, covering approximately 140,000 km2, with the aim of mapping the shallow subsurface architecture, aquifer connectivity, and geological structures.

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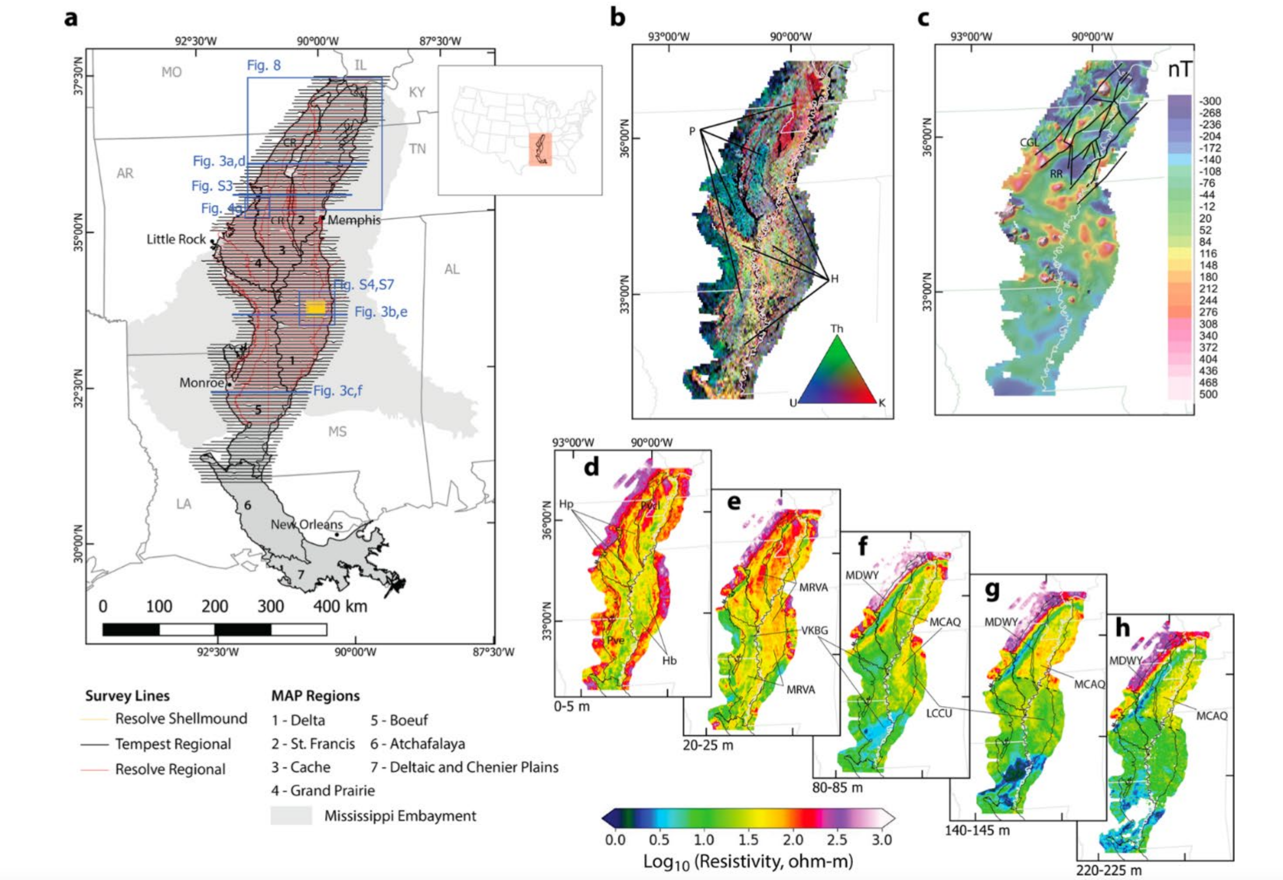

Problem: The Mississippi Alluvial Plain is home to a significant shallow aquifer system and is facing chronic groundwater decline. Beneath the region lies the Reelfoot rift and New Madrid seismic zone, posing poorly understood seismic hazards. Despite its importance, the shallow subsurface has not been adequately mapped.

Solution: The dataset underscores how regional-scale airborne geophysics can bridge observational gaps, providing smart insights for improved comprehension and management of subsurface structures.

The multiple phases of AEM mapping along with targeted ground-based and waterborne geophysical data collection, provide an excellent case study in the value of subsurface mapping over multiple scales.

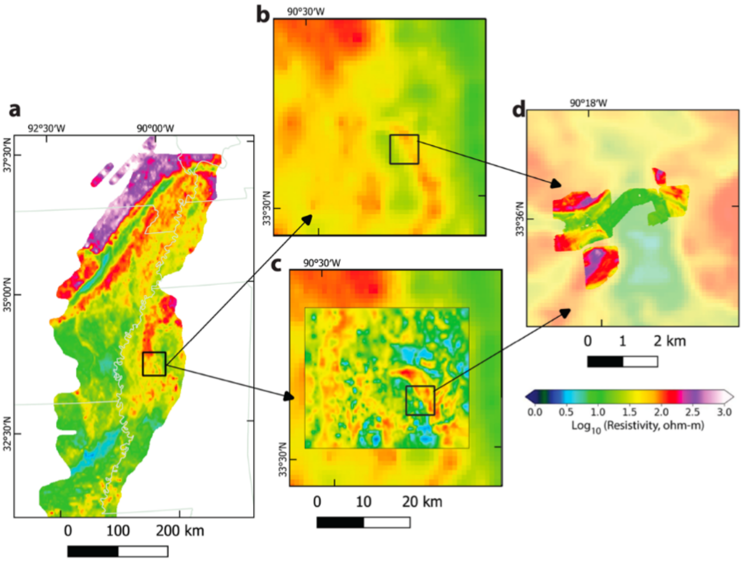

Fig. 9 Multi-scale mapping with airborne and ground-based methods. a Regional-scale structure mapped on 1 km grid cells interpolated from ~3 to 6 km-spaced flight-line data over the entire MAP region. **b** Regional-scale structure enlarged to the ~30 × 30 km Shellmound study area, compared with high-resolution structure mapped on 100 m grid cells interpolated from 0.25 to 1 km-spaced flight-line data from the Shellmound study area (**c**) shows the ability to resolve detailed buried channel structure. **d** Comparison of near-surface high-resolution Shellmound AEM data (background) with very high-resolution ground-based electromagnetic data[66] acquired with a sensor towed over ~4 km^2 on survey lines spaced by 25 m.

Methodology: Between 2018 and early 2020, over 43,000 flight-line-kilometers of airborne geophysical data were collected using high-resolution surveys over specific areas and regional surveys with 3–6 km line spacing. Data collection included airborne electromagnetics, radiometric, magnetic, and resistivity measurements.

Technologies: RESOLVE® AEM system + Fixed-wing time-domain TEMPEST® AEM system. The Resolve AEM system was flown in the first two phases, first in March 2018 for a high-resolution study near Shell mound, Mississippi, and again in the regional mapping effort from November 2018 to February 2019 that covered most of the MAP study area. The Resolve AEM system is a frequency- domain electromagnetic sensor that operates with six independent transmitter–receiver coil pairs at discrete frequencies from 400 to 140,000 Hz.

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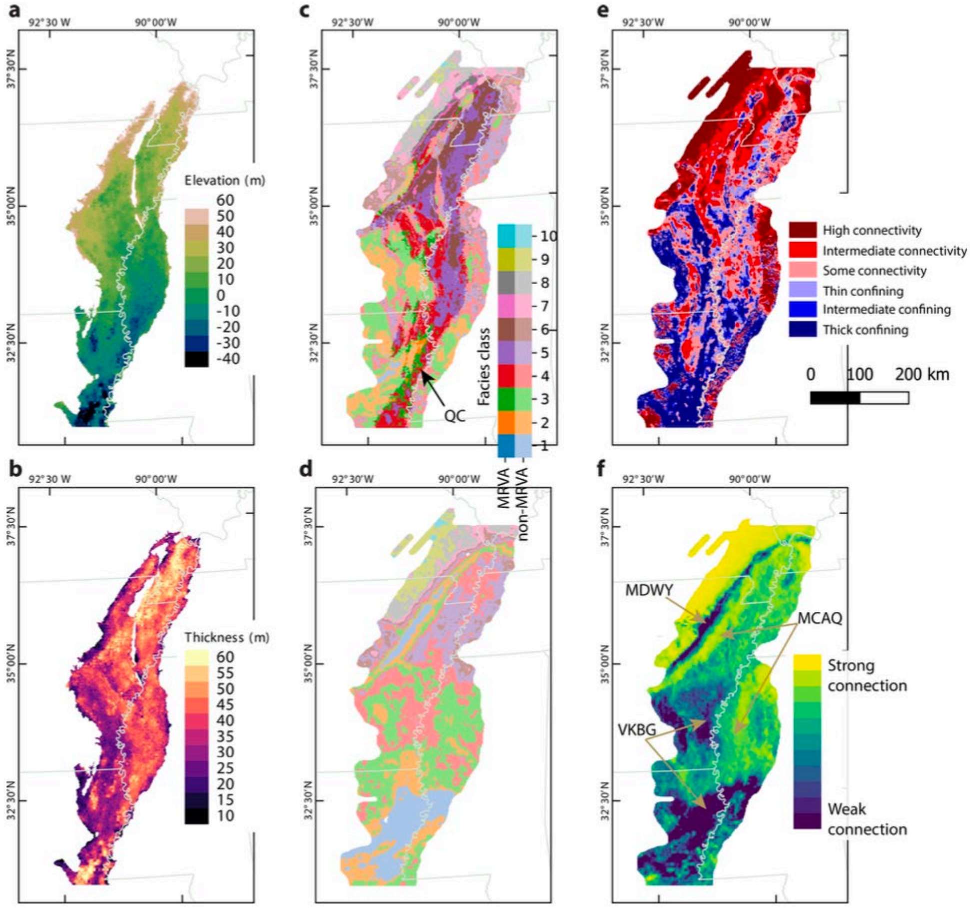

Fig. 5 Derived hydrogeologic products from AEM data. a Base of aquifer elevation surface determined from combined AEM and borehole data and **b** the aquifer thickness. Resistivity models grouped into facies classes at depths of 35–40 m (**c**) and 150–155 m (**d**). **e** Surficial confining and connectivity conditions based on the thickness and presence/absence of shallow low-resistivity facies classes. **f** Connectivity metric between the base of the MRVA and subcropping Tertiary unit defined as the vertically integrated electrical conductance within 25 m of the base of aquifer elevation (**a**). QC Quaternary channel, MRVA Mississippi River Valley alluvial aquifer, VKBG Vicksburg-Jackson confining unit, MCAQ Middle Claiborne aquifer, MDWY Midway confining unit.

Conclusion: The systematic mapping conducted using airborne geophysics offers a comprehensive understanding of the subsurface structures and hydrogeological features of the MAP region. The study demonstrates the utility of airborne geophysical surveys for regional-scale mapping and highlights the importance of such data for effective groundwater management and hazard mitigation strategies.

REFERENCES:

COMMUNICATIONS EARTH & ENVIRONMENT | (2021) 2:131 | https://doi.org/10.1038/s43247-021-00200-z | www.nature.com/commsenv