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HVSR passive seismic surveying to complement ground magnetic surveys for fluvial/alluvial gold deposits of the South Island, NZ

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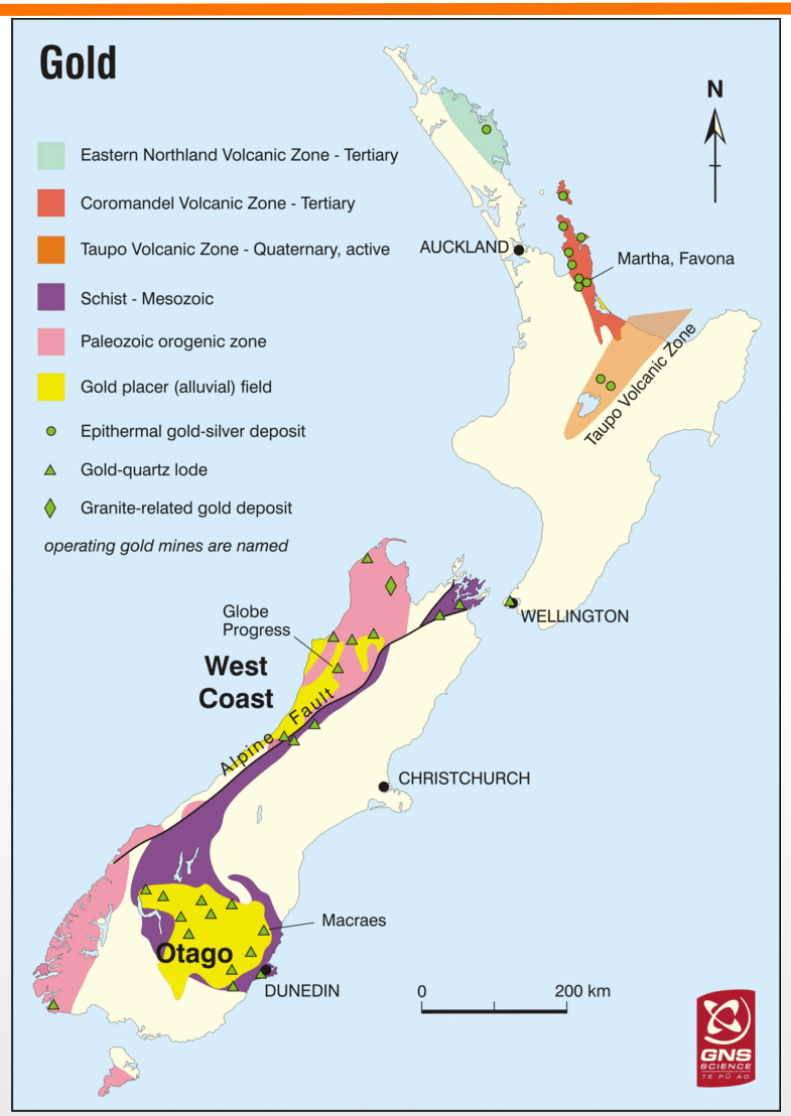
Outline

- NZ Gold
- Reefton Goldfield
- Primary gold sources
- Fluvial/alluvial gold deposits
- Study area
- GMAG survey and results
- HVSR Passive seismic survey and results
- Conclusions

NZ Gold



- 3 main goldfields in New Zealand
- **Coromandel Peninsula** – young epithermal gold and silver found in quartz veins within volcanic rocks
- **Otago** – orogenic gold found in quartz veins in Mesozoic schists and in adjacent river gravels and glacial deposits
- **West Coast & Golden Bay** – orogenic gold found in quartz lodes hosted in lower Palaeozoic metasediments and granite, and in adjacent Pliocene-Pleistocene glacial deposits and Pleistocene-recent river deposits and terraces
- **Taupo Volcanic Zone** – Gold in active geothermal deposits which are not mined

Image reproduced from http://5themesofnewzealand.blogspot.com.au/

Reefton Goldfield

- NNE trending belt of metamorphosed sediments
- Occupies an area 35km x 10km in the foothills of the Victorian Ranges
- Bounded by uplifted Karamea granitoids in the east and the down-thrown Grey-Inanguhua Depression to the west
- Includes hard rock gold deposits and alluvial/fluvioglacial gold deposits
- Predominantly Palaeozoic host rocks with minor Mesozoic host rocks
- Largest historic gold producers are the Blackwater and Globe-Progress gold mines

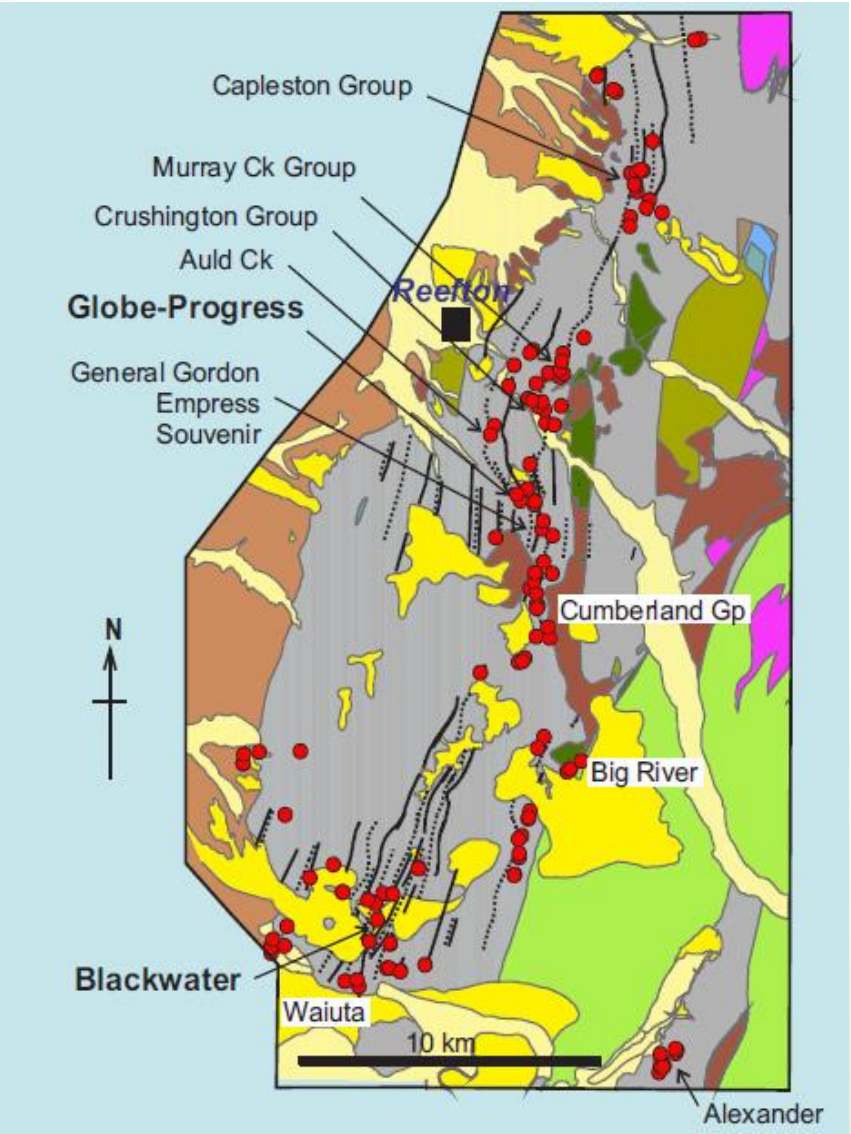


Image reproduced from Christie et al, 2006

Reefton Style Gold Deposits

- Orogenic gold deposits
- Gold-bearing quartz lodes and disseminated gold
- Hosted in Ordovician metasedimentary rocks of the Greenland Group, (metamorphosed sandstone, siltstone and mudstone as turbidites)
- These rocks have been folded, faulted and metamorphosed to greenschist facies, the last phase during intrusion by Devonian Karamea Suite granites, which are related to the main gold mineralising event

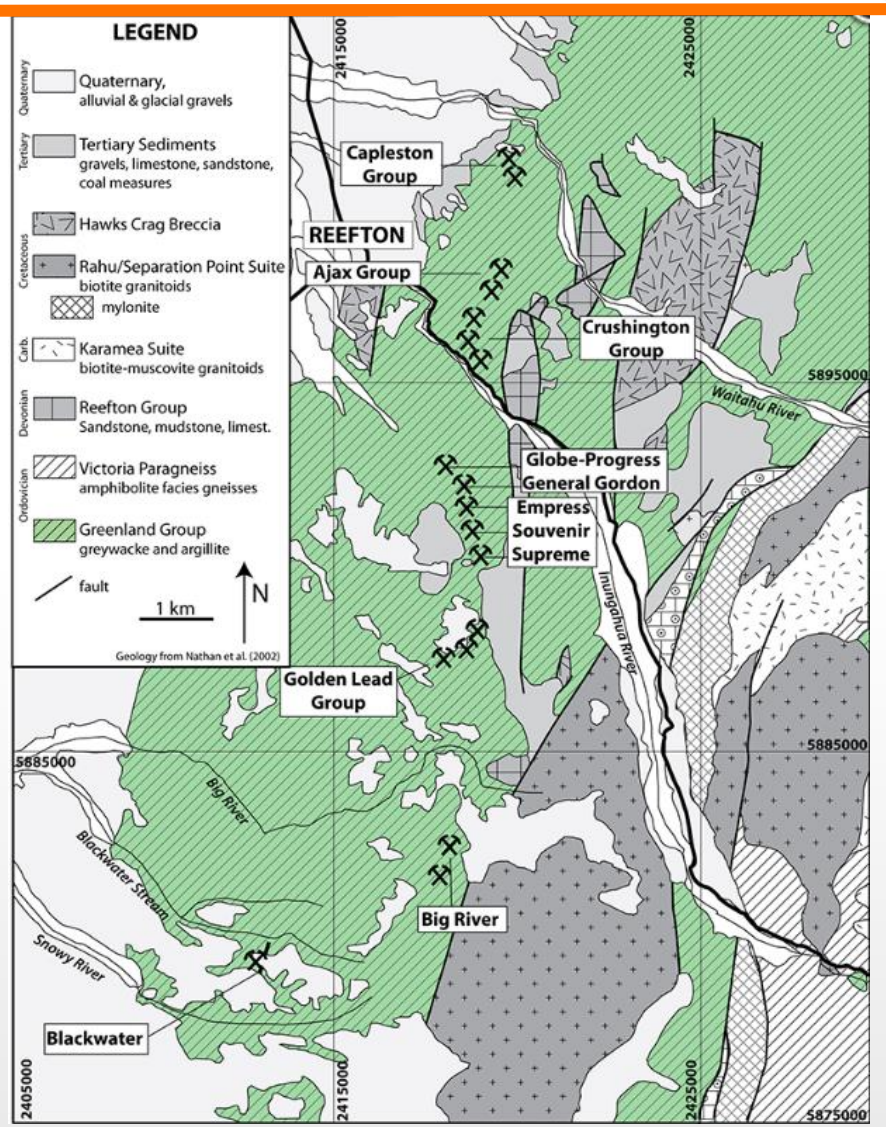
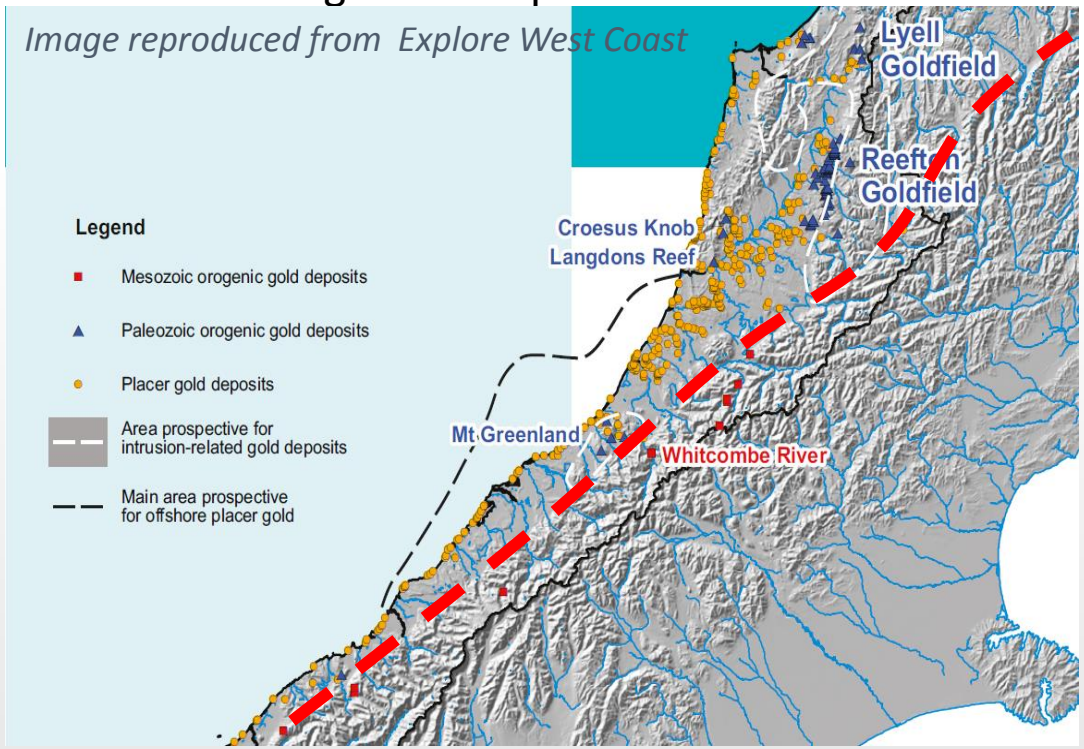


Image reproduced from MacKenzie et al, 2016

Reefton Placer Gold Deposits

- Multiple alluvial and fluvioglacial gold deposits occur within the Reefton Goldfield
- Regionally, the primary gold sources for Pleistocene to recent fluvial and alluvial gold deposits associated with modern rivers and creeks include:
  - catchment areas containing Greenland Group metasedimentary rocks and Karamea Suite granites
  - glacial till deposits containing eroded remanets of Reefton style gold mineralised rocks
  - secondary eroded glacial Greenland Group gravels in Pliocene “Old Man Group” gravels to sandstone beds forming hills and plateaus.

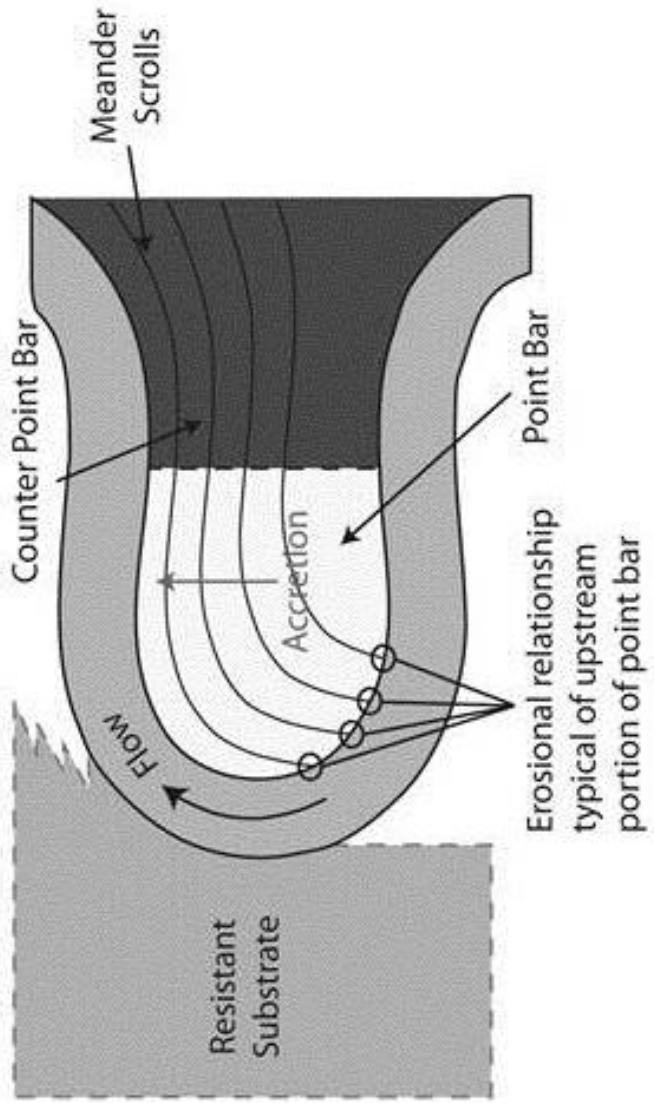


Fowler Survey Area

- Located on a point bar on the northern bank of a major river draining to the southwest
- Bounded to the north by a ridge of basement rocks
- Very thick vegetation containing loravine, gorse and blackberry bushes
- Very swampy in some places
- Up-river, proximal to survey area 1:250K geology map suggests both Greenland Group metasediments and Karamea Suite granites are present

Fowler Survey Area

- Point bars are built on successive accumulations of river facies deposits
- They form by the interplay of erosion and growth during normal river conditions, which can become truncated during flood events where the river access cuts across the point bar deposits
- Certain phases of river deposits containing coarse grained gravels and heavy minerals can be preserved within the point bar complex
- River deposits containing coarse grained gravels and heavy minerals may also have increased accumulation of alluvial gold particles
- These higher grade river deposits may have corresponding magnetic anomalies and show deeper incision than adjacent lower grade river deposits



Fowler GMAG Survey

- Detailed GMAG surveying using 20m survey line spacing carried out to assist in locating buried river paleochannels and terraces containing increased magnetic heavy mineral concentration in fluvial or alluvial gravel and fan deposits, including pot holes and other trap sites with higher magnetic intensity formed along the deposit length
- Focus on targeting magnetic anomaly highs for higher grade zones of alluvial gold mineralisation for auger drill testing, pitting and trenching
- High alluvial gold concentration deposits to be marked out for open cast mining using dredging methods

Fowler GMAG Survey

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» The relative concentration of magnetite and gold grains will depend on:

1) Occurrence of primary gold deposits from quartz veins in Palaeozoic host rocks and secondary Pliocene to Pleistocene glacial till deposits containing these types of rocks located up stream

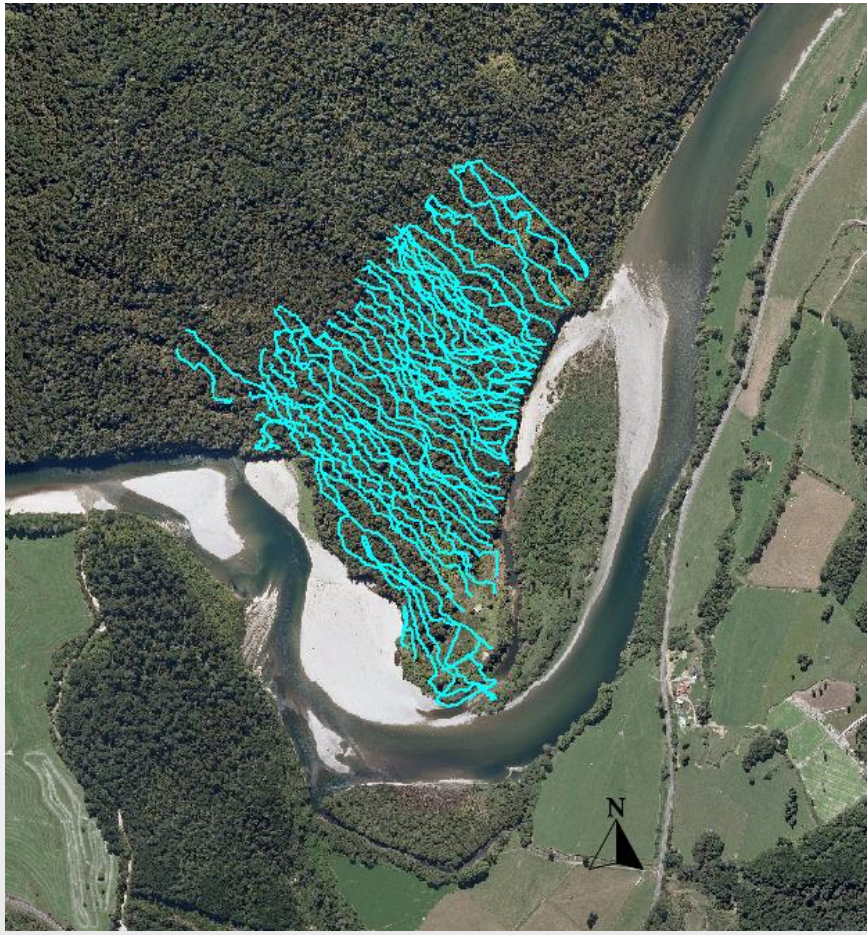
2) Distance from the primary gold source, magnetite source and magnetite gravel source

3) High-water energy deposit site to trap and concentrate heavy minerals

» Not all alluvial deposits will have magnetite and gold concentrated together – but will likely increase the chances of finding associated increases in alluvial gold concentration

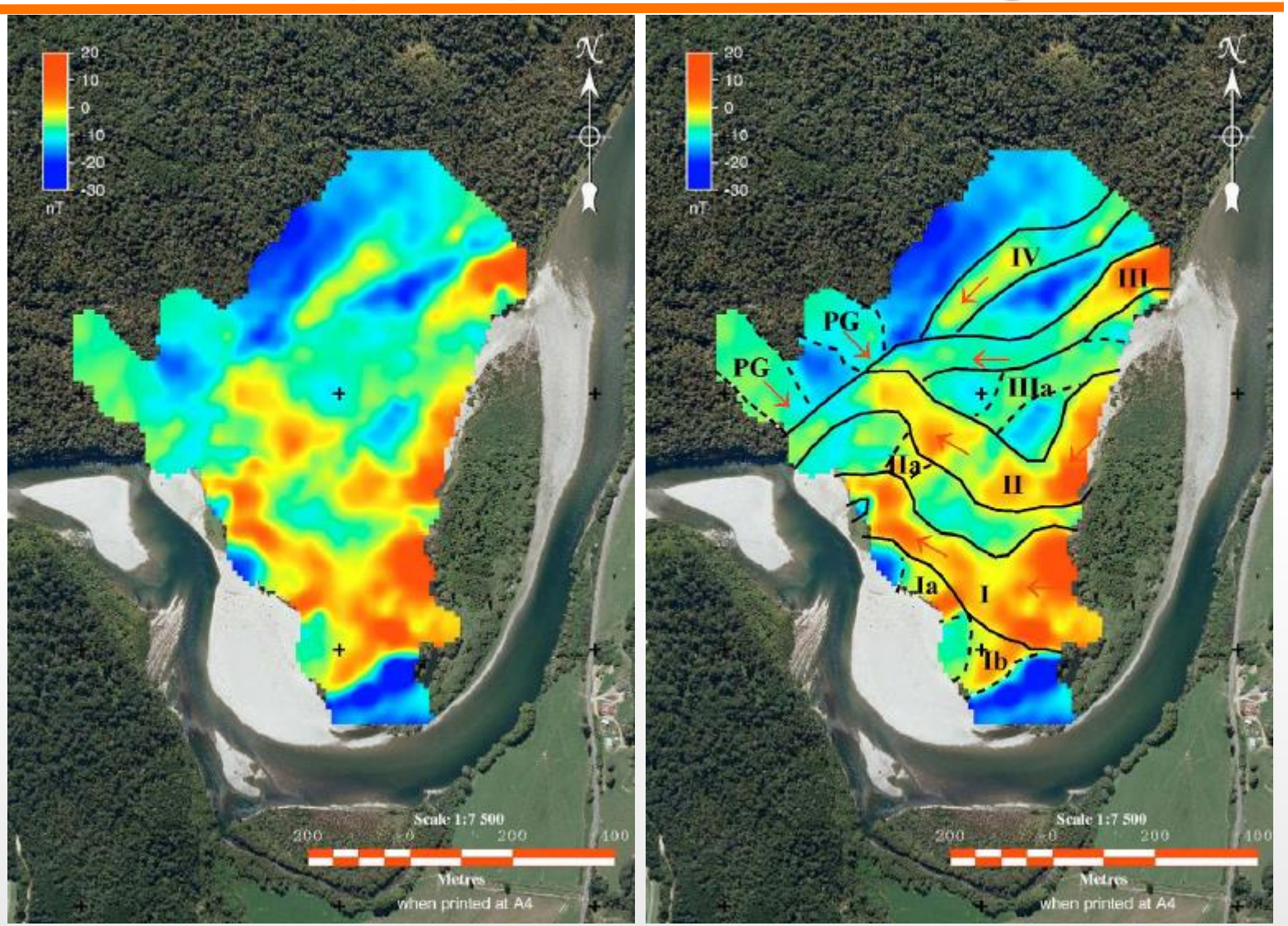
Fowler GMAG Survey

- Geometric G-859 Cesium vapour roving magnetometer
- Geometric G-856 proton precession base station magnetometer
- Survey lines orientated NW-SE
- 20m survey line spacing
- ~24 line km acquired



Fowler GMAG Survey Results and Preliminary Interpretation

- Magnetic anomaly trends interpreted to represent paleochannels with varying concentration of magnetite and magnetic cobbles
- Roman numerals are used to label the paleochannels as a progression back in time, “I” is earliest and “IV” is oldest. Showing the formation of the point bar complex.
- The GMAG survey has potentially identified the higher grade gold zones for mining



Fowler Passive Seismic Survey

- Passive seismic survey using the HVSR method to assist with identifying buried channels and terraces that could form trap sites to host alluvial gold deposits.
- The alluvial deposit consists of poorly consolidated and imbricated gravels and cobbles that unconformably overly incised bedrock or older river and alluvial deposits
- Bedrock is usually comprised of older sedimentary units, predominantly well consolidated calcareous siltstone (often called papa), which has a higher acoustic impedance.
- Passive seismic surveying may detect the locations of deeper channels cut into the papa

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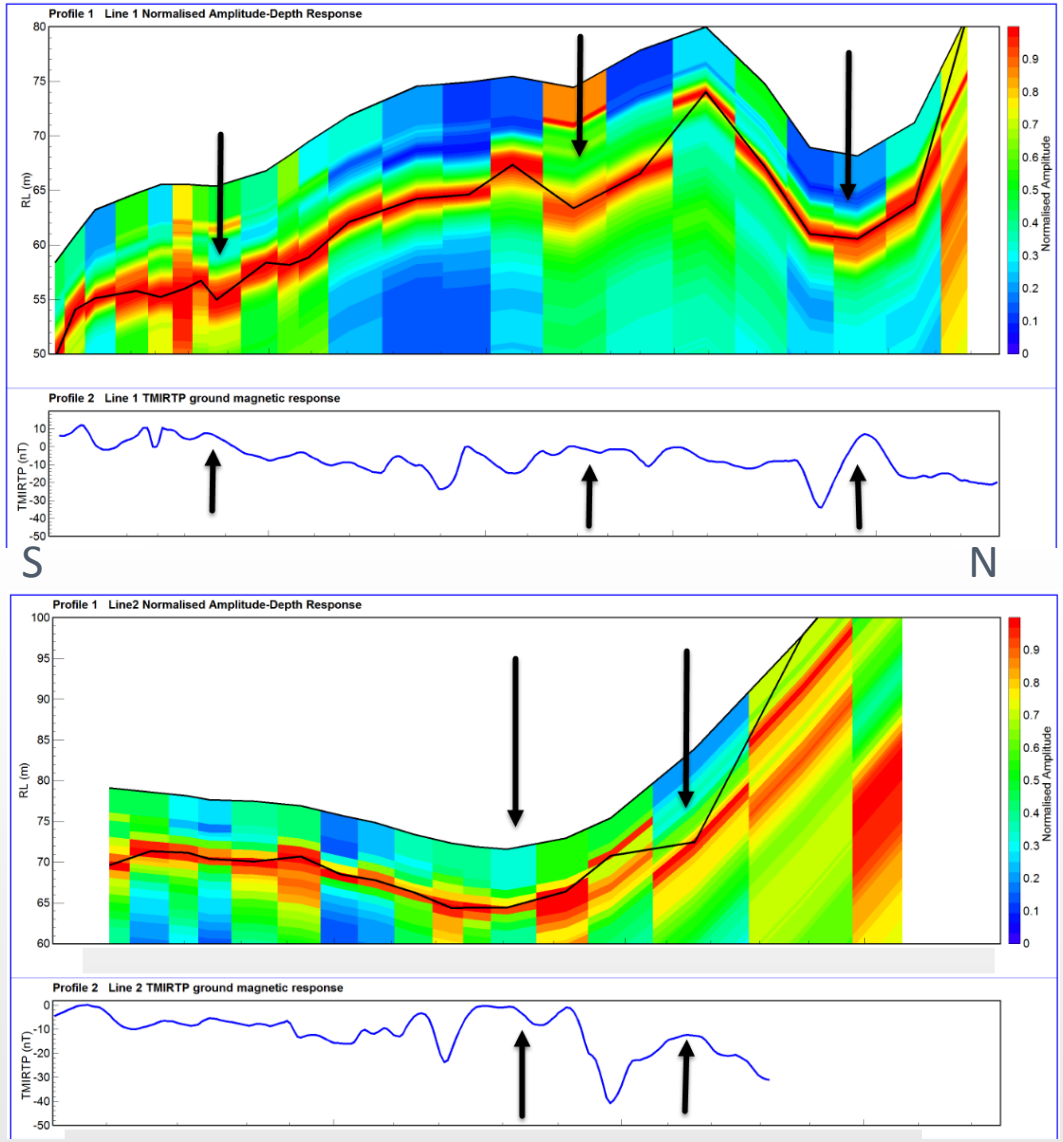
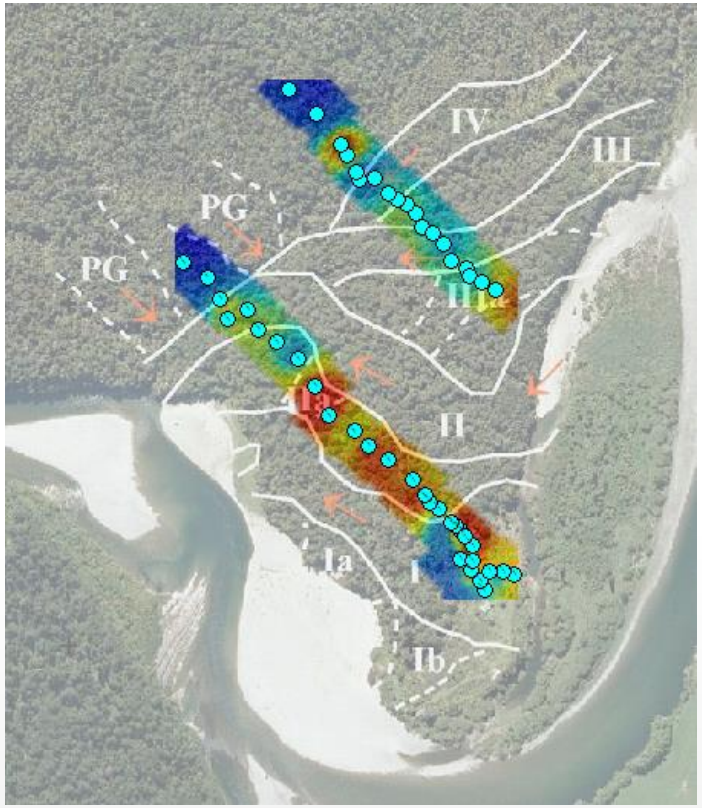
HVSR Trial Passive Seismic Surveying

- Completed using a Tromino 3G seismometer
- 2 trial lines completed on NW orientated survey traverses roughly along GMAG survey lines for comparison
- 40m station spacing, 300m survey line spacing, 20min recording time, 128Hz Sampling Frequency
- Internal GPS system had trouble finding signal due to thick vegetation, therefore external GPS antenna was used to increase GPS signal
- Relatively good coupling with ground – but some stations we not so good due to tree roots and thick humus layers

HVSR Trial Passive Seismic Results

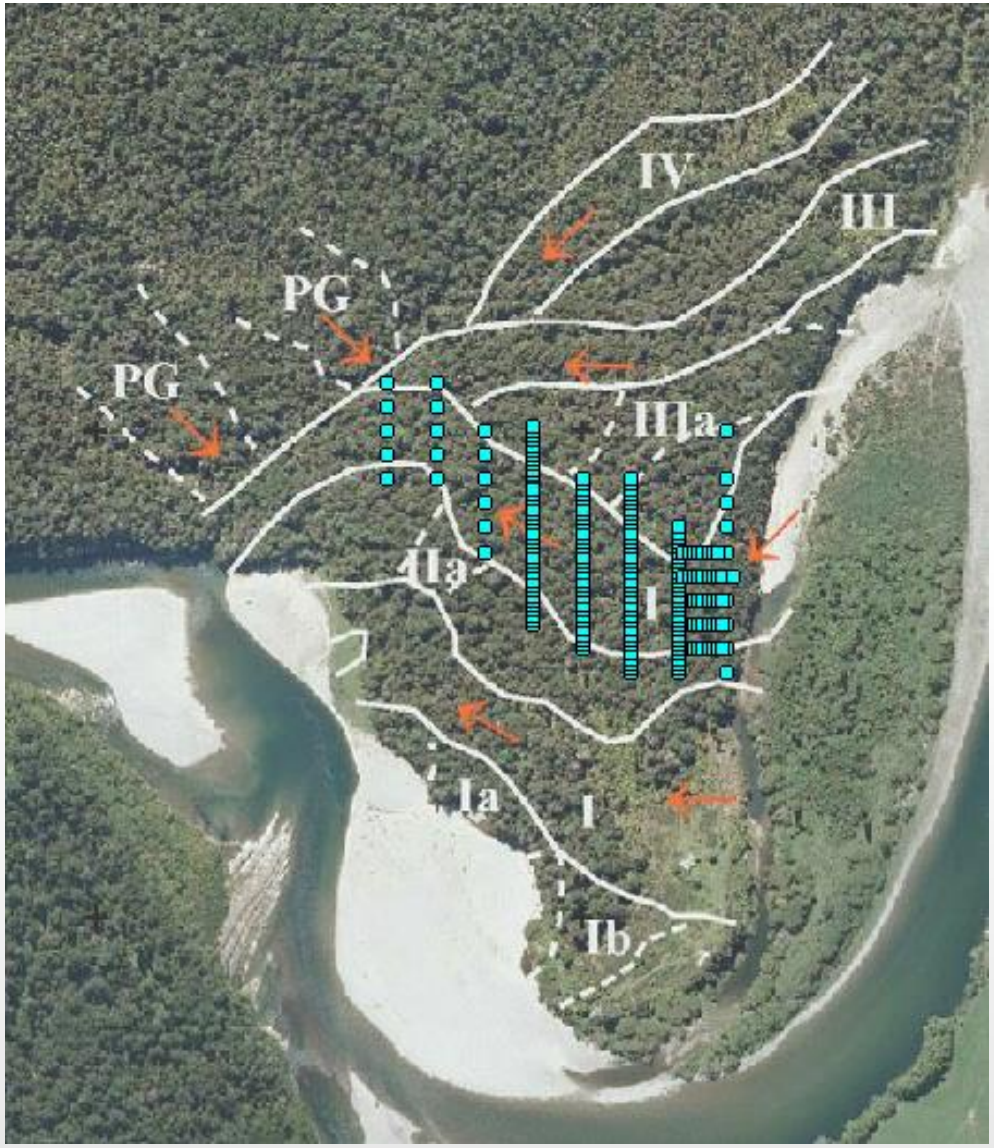




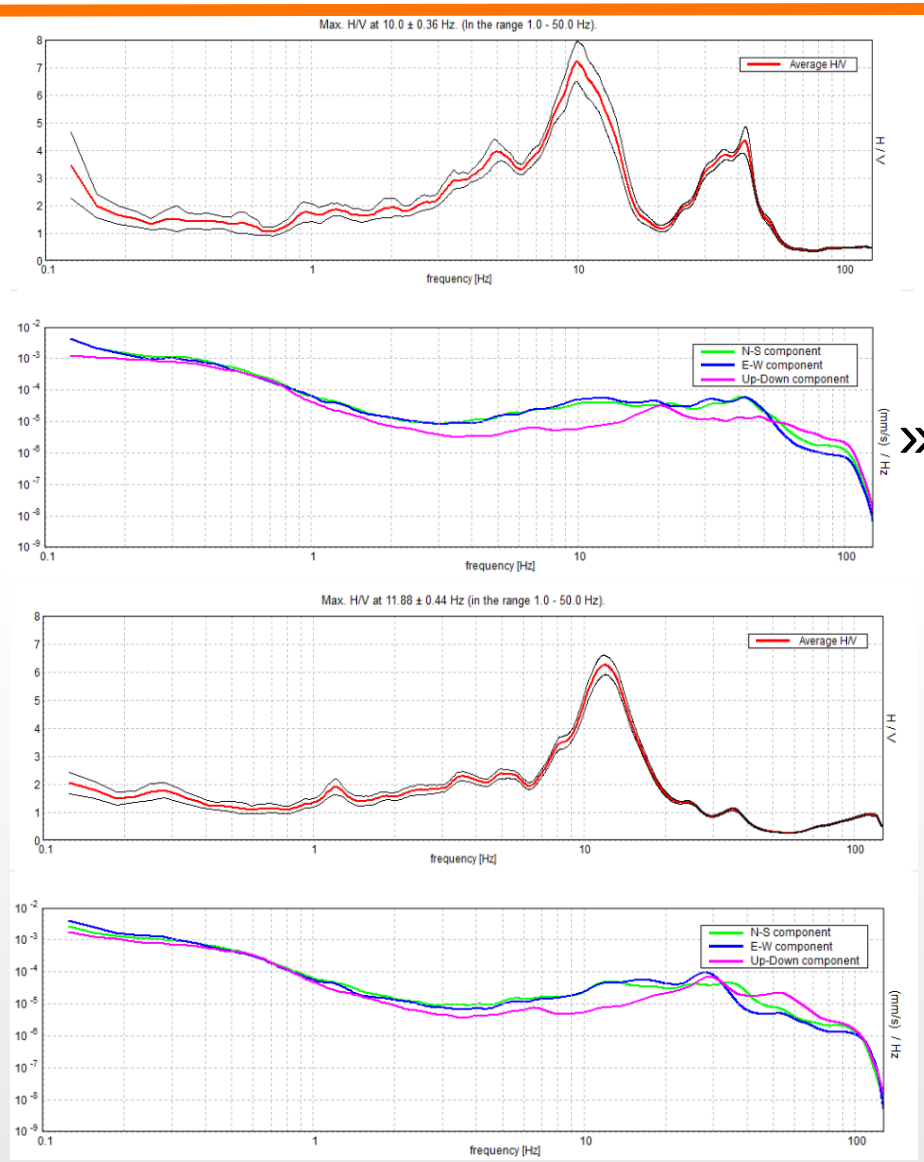
- Reasonably good correlation between mag highs and identified paleochannel axes
- Passive seismic is working well to identify the papa interface

Follow-up detailed HVSR Passive Seismic Survey

- Follow-up detailed Passive Seismic survey completed on N-S orientated survey lines
- 50m survey line spacings
- Initially, 25m station spacing and then infilled to 5m
- 20min recording time
- 128Hz sampling frequency
- Used measuring tapes and laser level surveying equipment to get accurate locations in thick forested areas where there was no GPS signal



Follow-up detailed HVSR Passive Seismic Survey Results

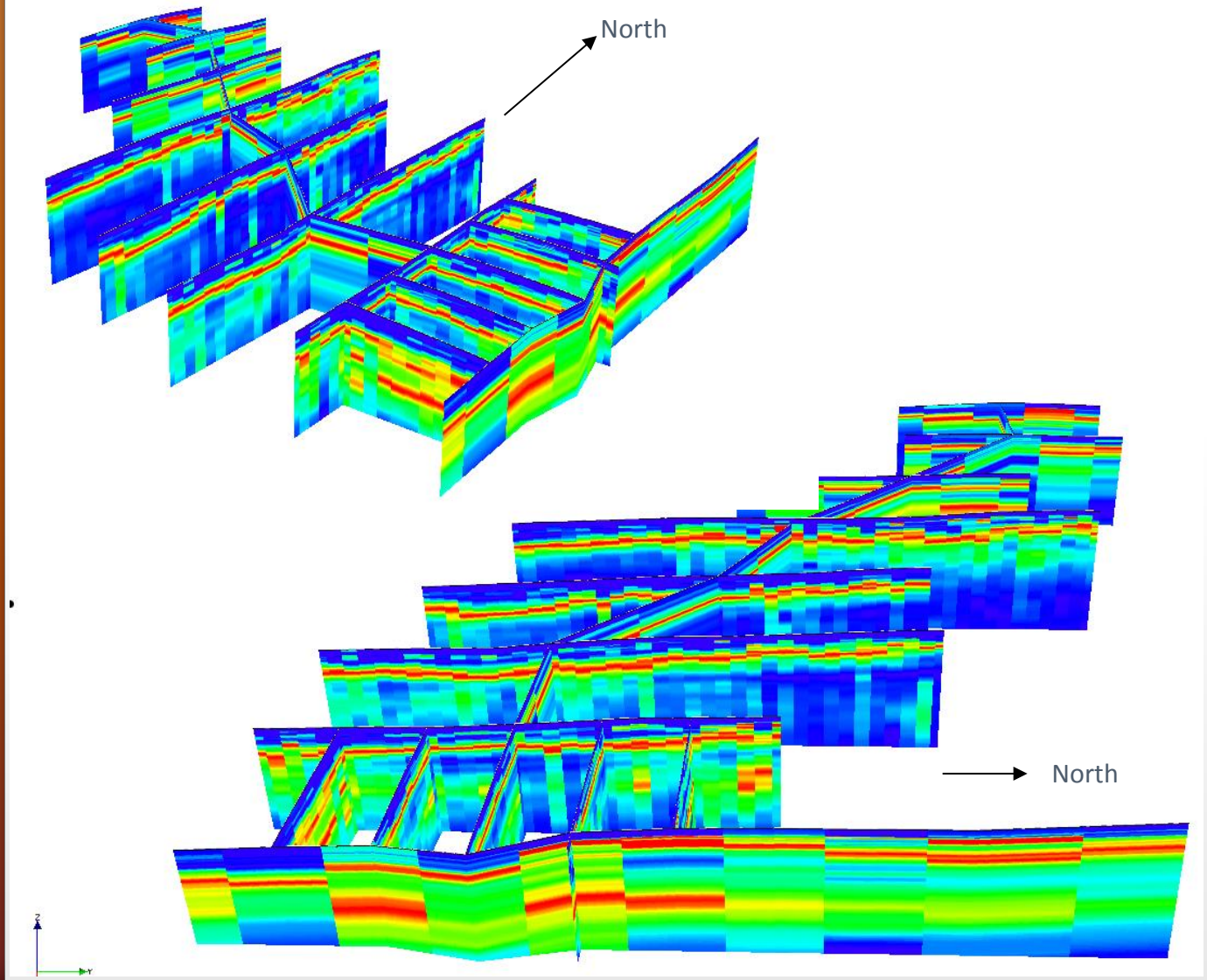


» 3 layer response (higher HVSR peak frequency could represent harder clay layers within the alluvial deposits)

» High amplitude signal indicating good impedance contrast and strong ambient source signal

» 2 layer response

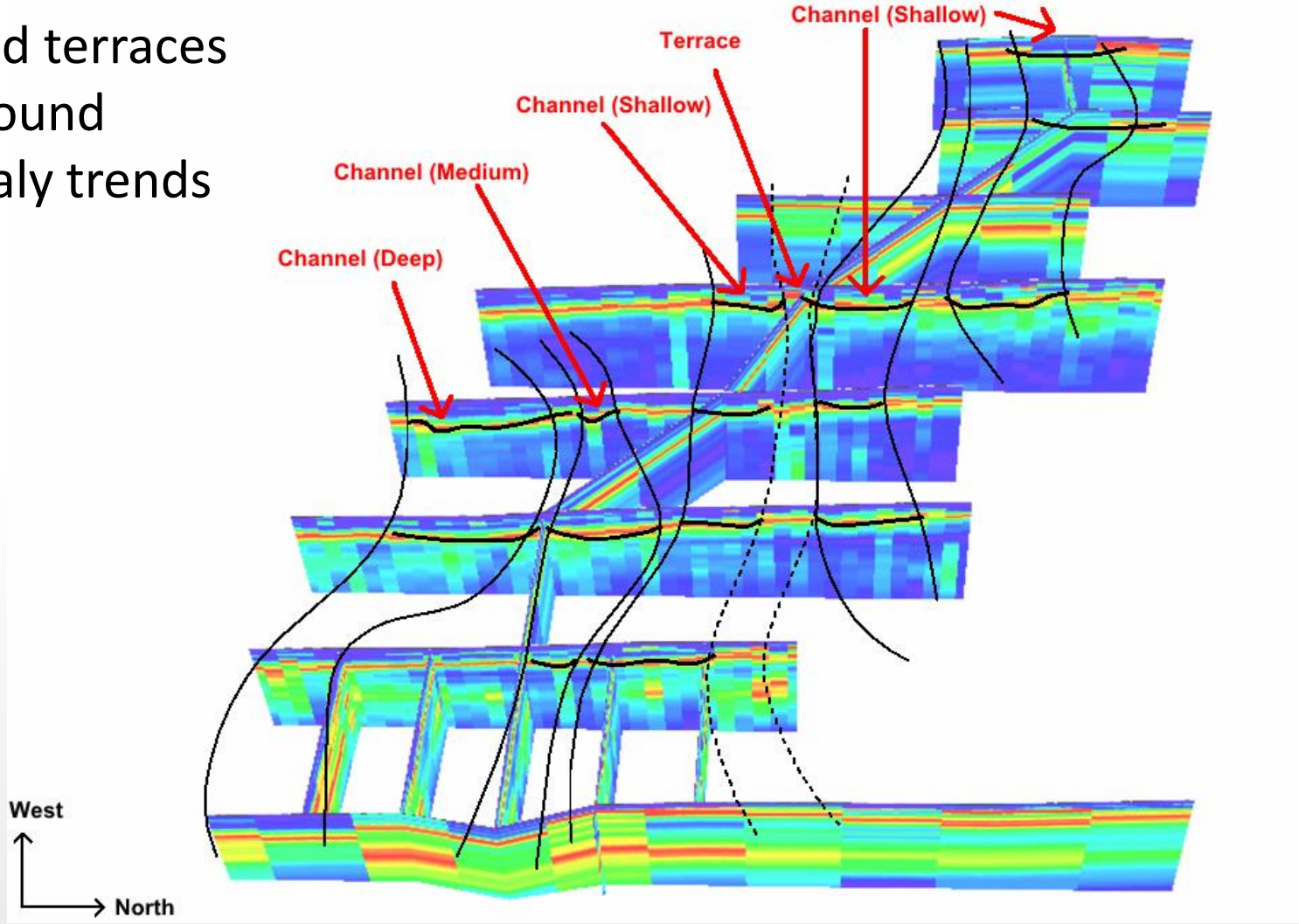
HVSR Passive Seismic Results – Fence Diagrams



- No drilling or trenching available to constrain the Vs in the survey area
- Used Vs = 400m/s
- Depth range 4m-20m, averaging 9m
- Recent trenching has shown that the papa layer is intersected at ~9m , agreeing with the passive seismic prediction

HVSR Passive Seismic Results – Preliminary Interpretation

» Channel axes and terraces are following ground magnetic anomaly trends



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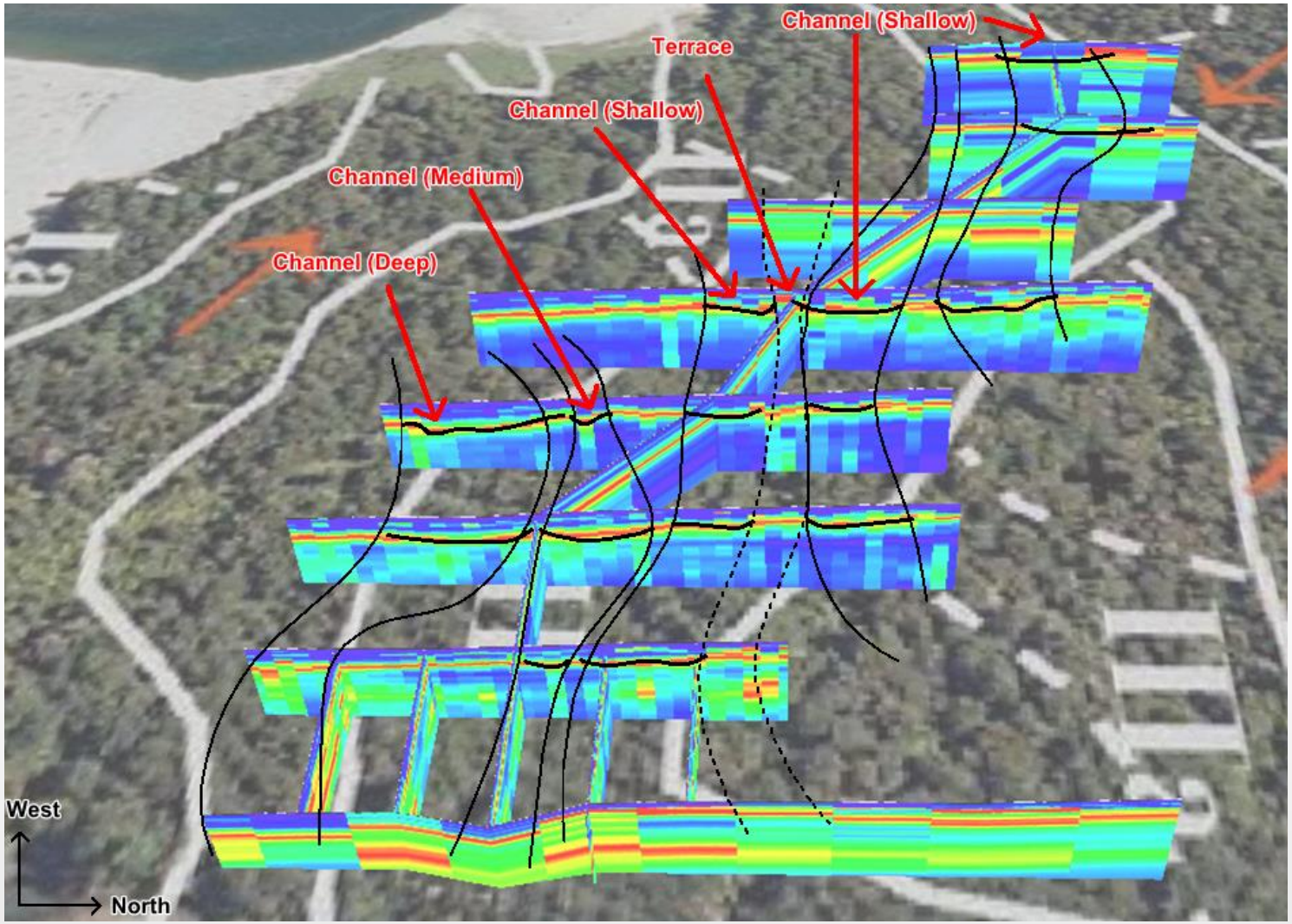
HVSR Passive Seismic Results – Preliminary Interpretation



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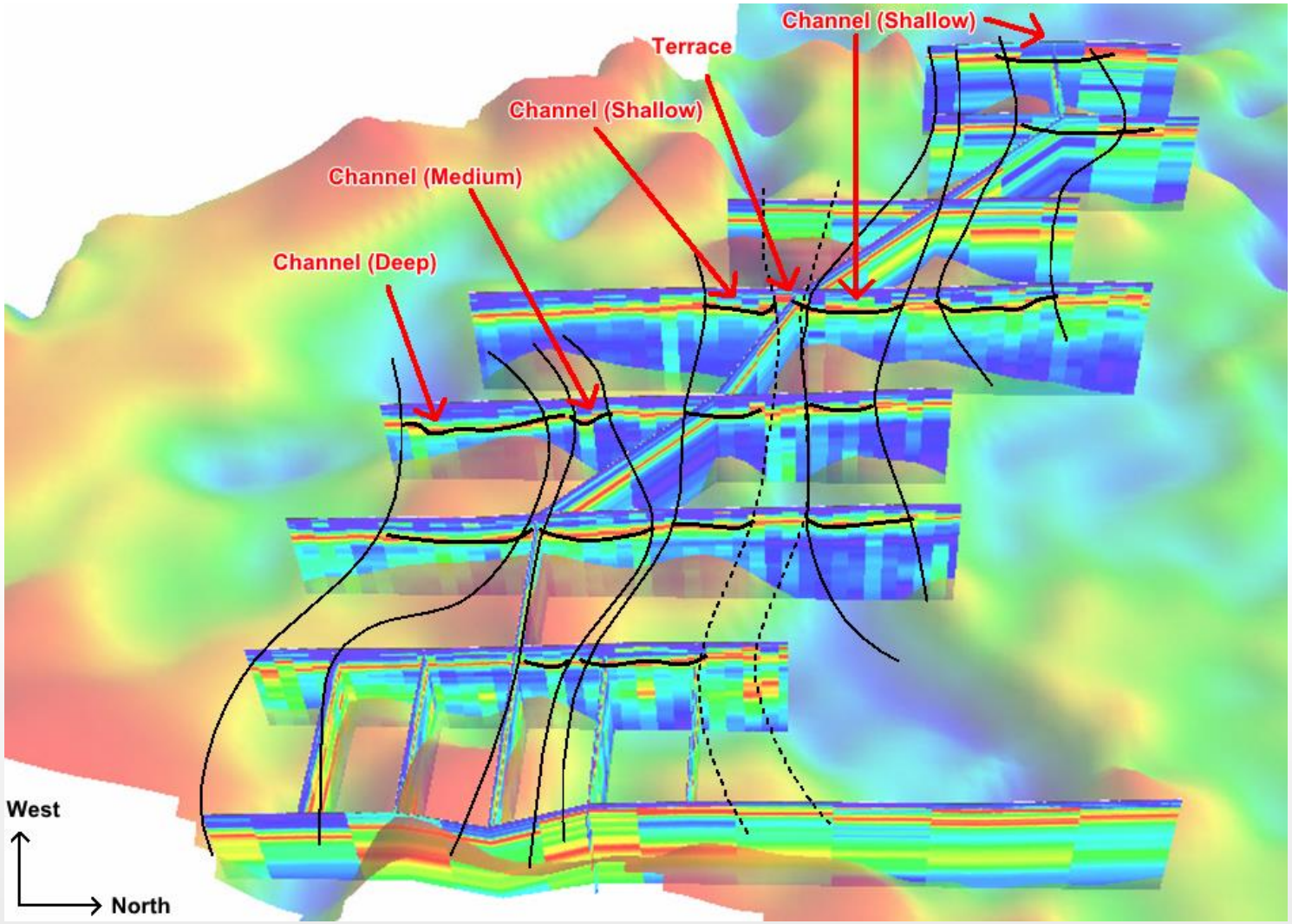

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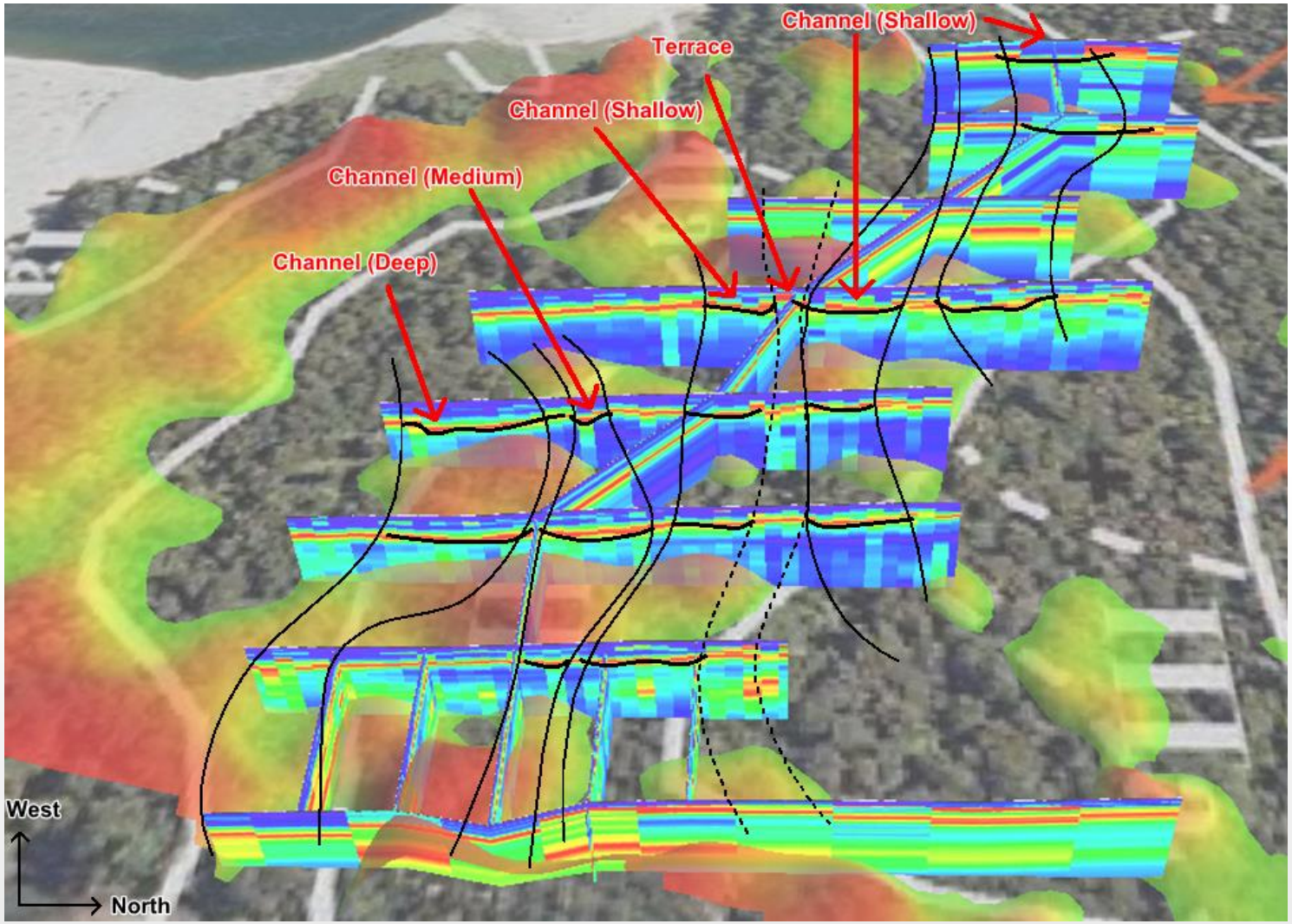
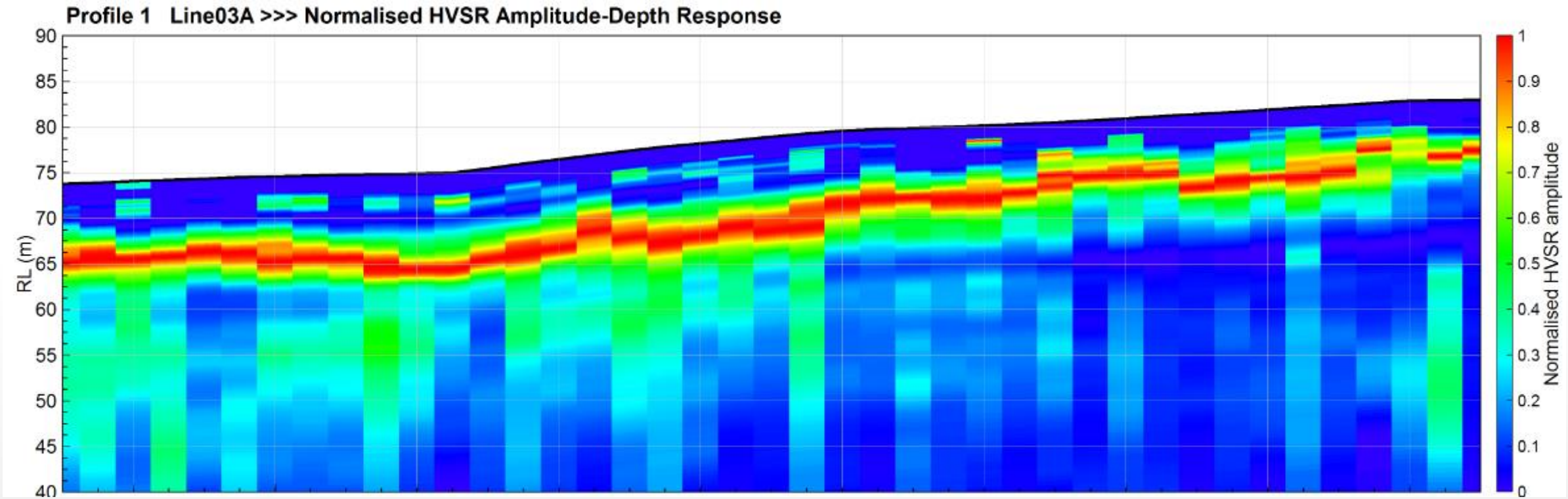
HVSR Passive Seismic Results – Preliminary Interpretation



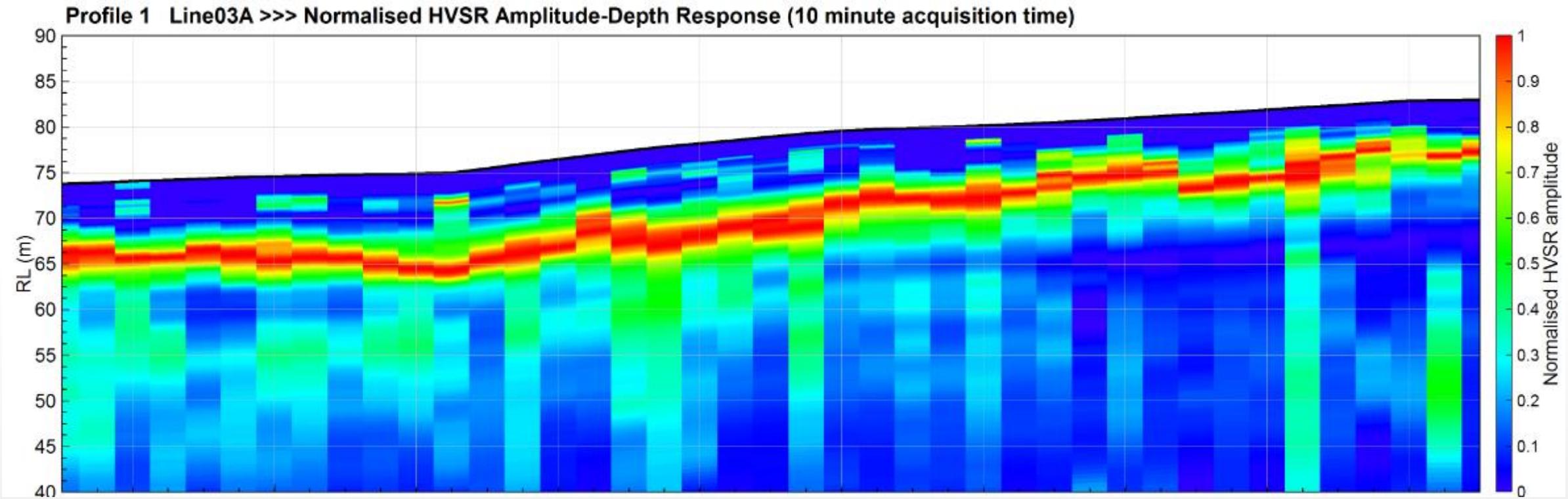
HVSR Passive Seismic Results

» 20min Acquisition Time



HVSR Passive Seismic Results

» 10min Acquisition Time



Conclusions

- Very subtle geophysical anomalies in ground magnetic and HVSR passive seismic survey datasets have identified prospective buried river channel and terrace deposit targets for hosting higher concentrations of alluvial gold
- 5m passive seismic station spacing along survey lines is recommended to accurately resolve the subtle topographic variations in the river base to produce heavy mineral trap sites
- 10min recording time is sufficient for mapping thickness of relatively thin (0-20m) fluvial/alluvial deposits in this region
- The combination of high resolution ground magnetic surveying (20m line spacing or less) and high resolution passive seismic surveying has the potential to become a standard mapping and targeting strategy for alluvial gold deposits in the rest of NZ and world-wide.

Thank You

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