A brief analysis of MobileMT data

Daniel Sattel

EM Solutions

SEG Natural Source EM for Mining Applications workshop
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MobileMT – acquisition

- natural-field EM system designed by Petr Kuzmin and operated by Expert Geophysics Limited (EGL)
- wide frequency range 25 Hz – 20 kHz, sampling rate 98 kHz
- records three-component airborne dB/dt data (1.4 m diameter coils)
- base station records horizontal E-field data with 2 pairs of orthogonal sensors (signal & reference), separated by ~30 m
- cesium magnetometer (Geometrics G-822A)

MobileMT – acquisition

MobileMT – acquisition

MobileMT - processing

$$\begin{pmatrix} Hx \\ Hy \end{pmatrix} = \begin{pmatrix} Yxx\,Yxy \\ Yyx\,Yyy \end{pmatrix} \begin{pmatrix} Ex \\ Ey \end{pmatrix}$$

Y = admittance

$$Y_{DET} = \sqrt{YxxYyy - YyxYxy}$$

$$\sigma^{app} = \mu\omega \left| Y_{DET}^2 \right|$$

$\varphi = \arg\left(Y_{DET}^2\right)$ not (yet) provided

Hz data currently not used, but roving tipper could be derived from *Hx*, *Hy* & *Hz* data

Petr Kuzmin's comment: Hz data is used in the processing to derive Total Field from *HxHyHz*. The expression above is a simplified expression.

MobileMT – processing, 2D case:

$$Y_{DET} = \sqrt{-YyxYxy} = \sqrt{-Y_{TM}Y_{TE}}$$

$$\sigma^{app} = \frac{1}{\sqrt{\rho_{TE}^{app}\rho_{TM}^{app}}} \qquad \varphi = \frac{1}{2}\left(\varphi_{TE} + \varphi_{TM}\right)$$

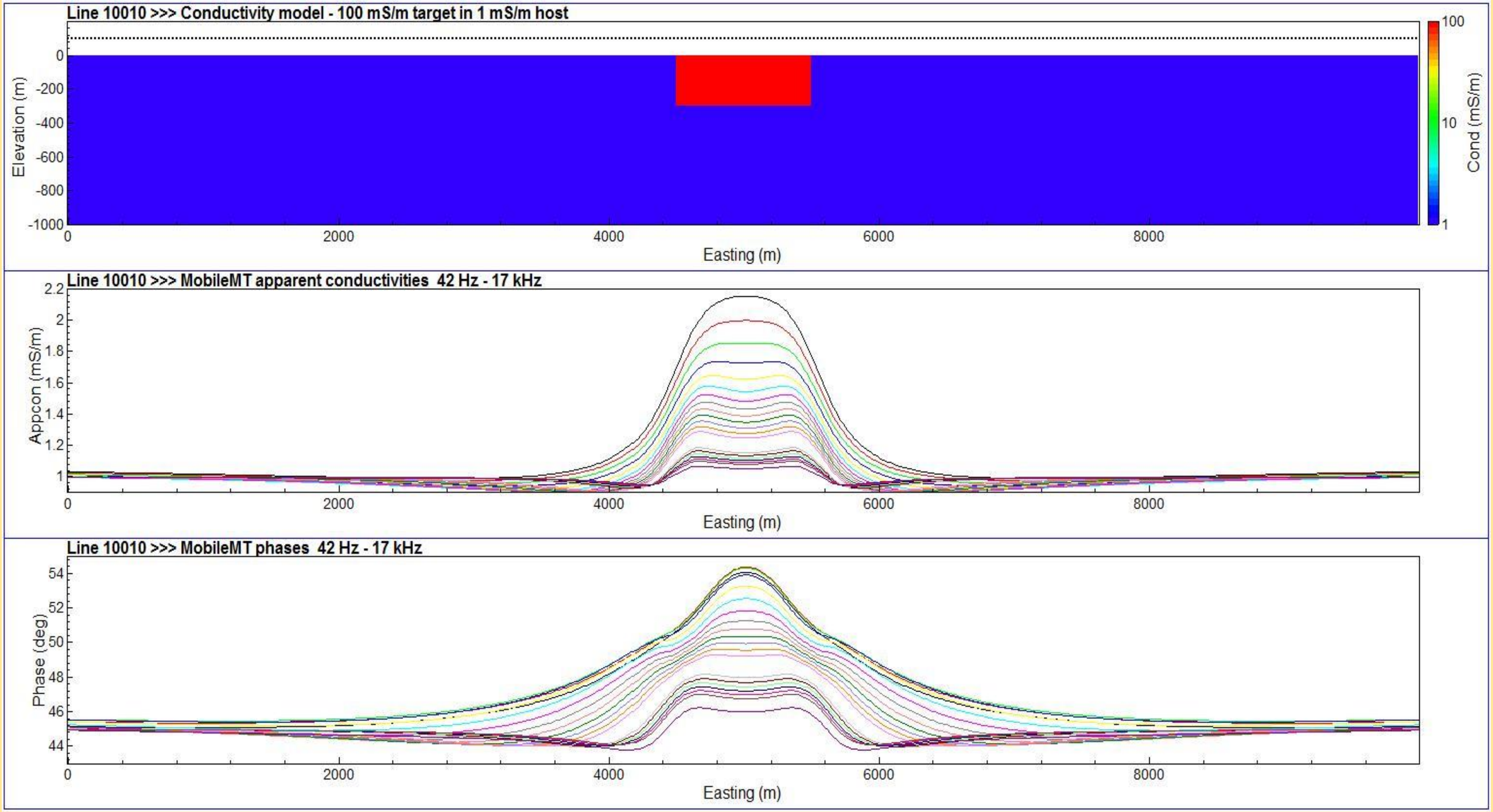
Parameters independent of strike direction – see also:

Pedersen, L.B. and Engels, M., 2005, Routine 2D inversion of MT data using the determinant of the impedance tensor, Geophysics 70, G33-G41.

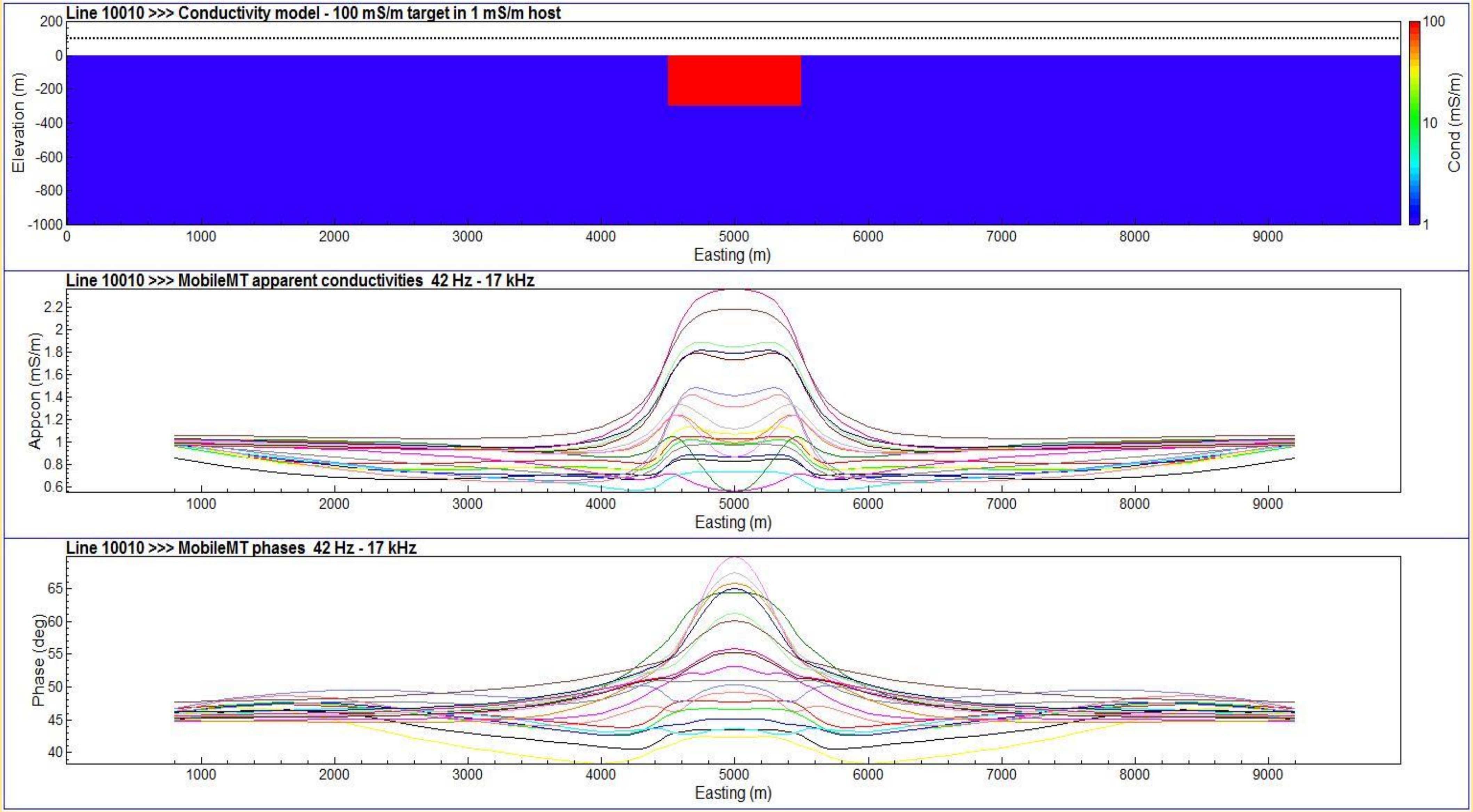
MobileMT - Products

- Apparent conductivity grids
- 2D inversions (Occam2D, Wannamaker & Constable)
- 3D forward modeling (UBC-GIF *MT3Dfwd*)
- 3D inversions

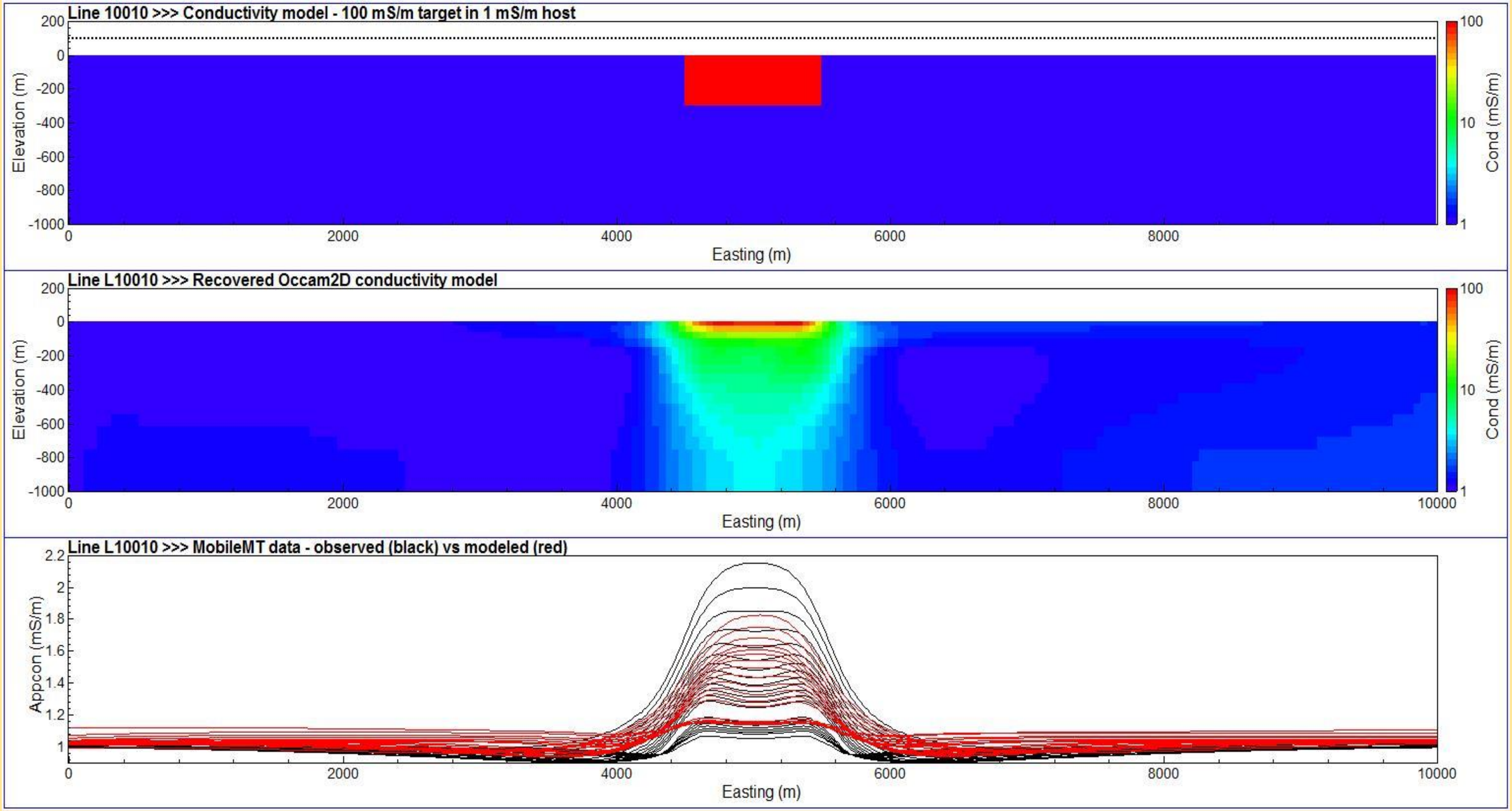
2D synthetic data modeling (Wannamaker & Constable)



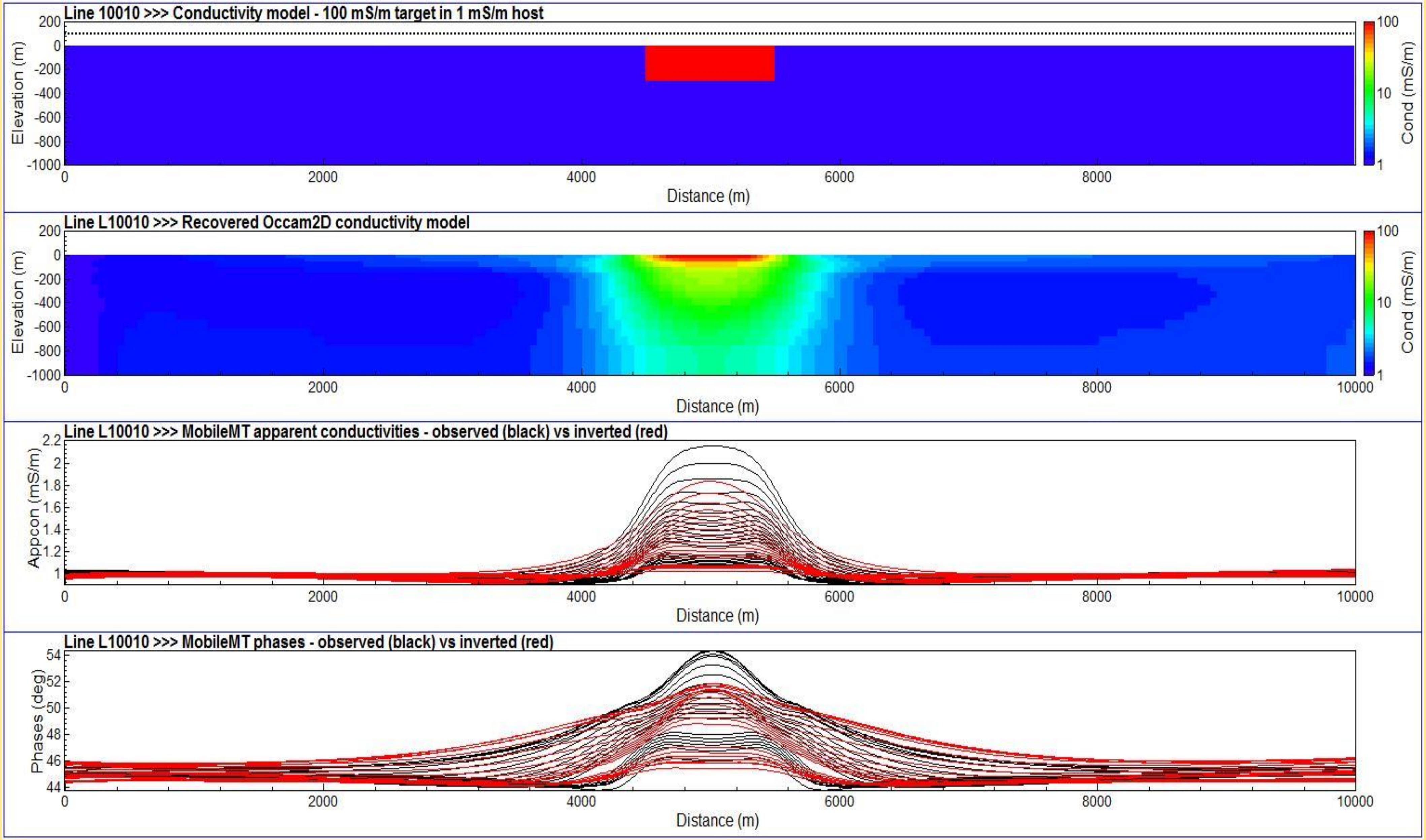
3D synthetic data modeling (UBC-GIF) – 10 km strike



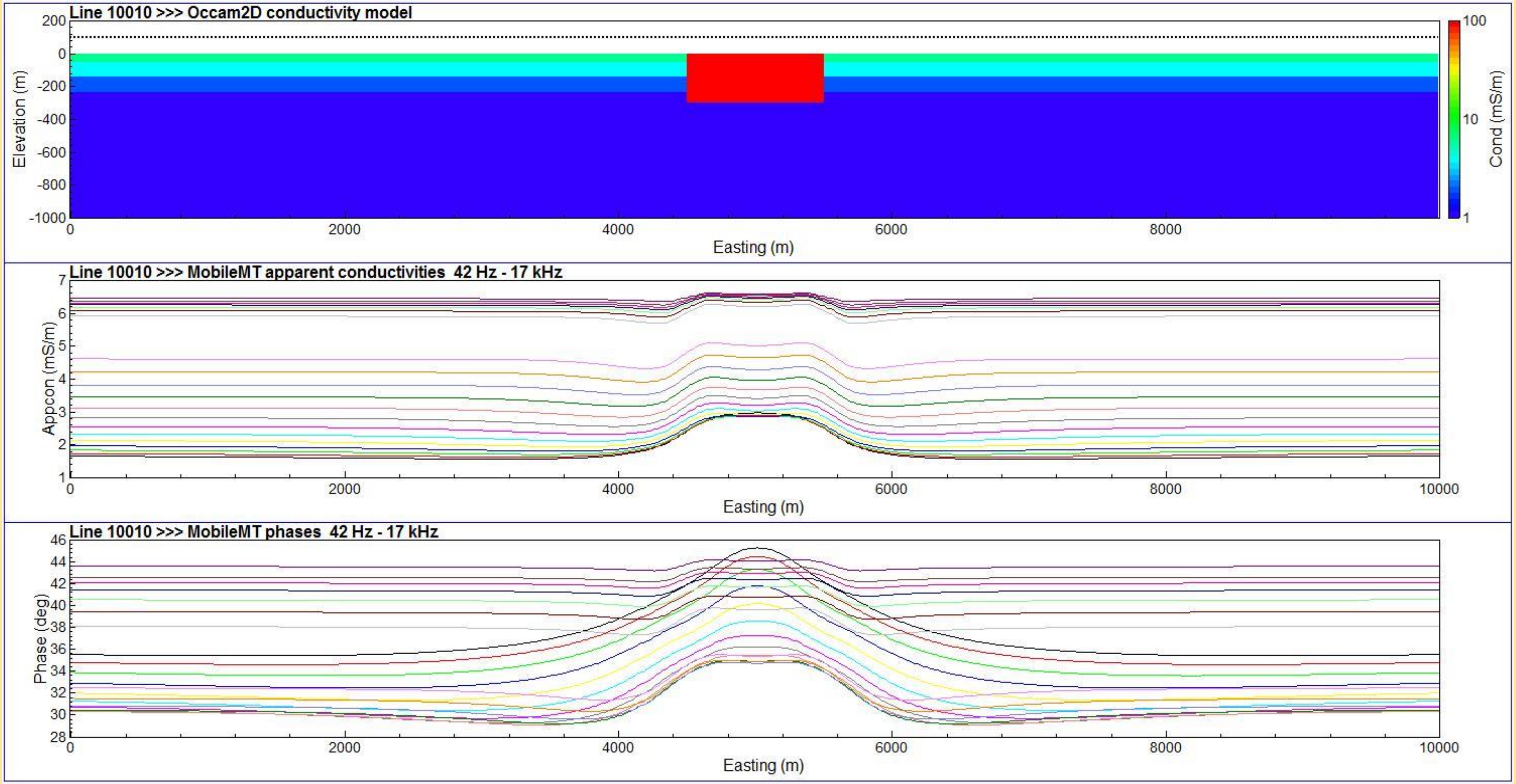
2D synthetic MobileMT data inversion of appcon



2D synthetic MobileMT data inversion of appcon & phase

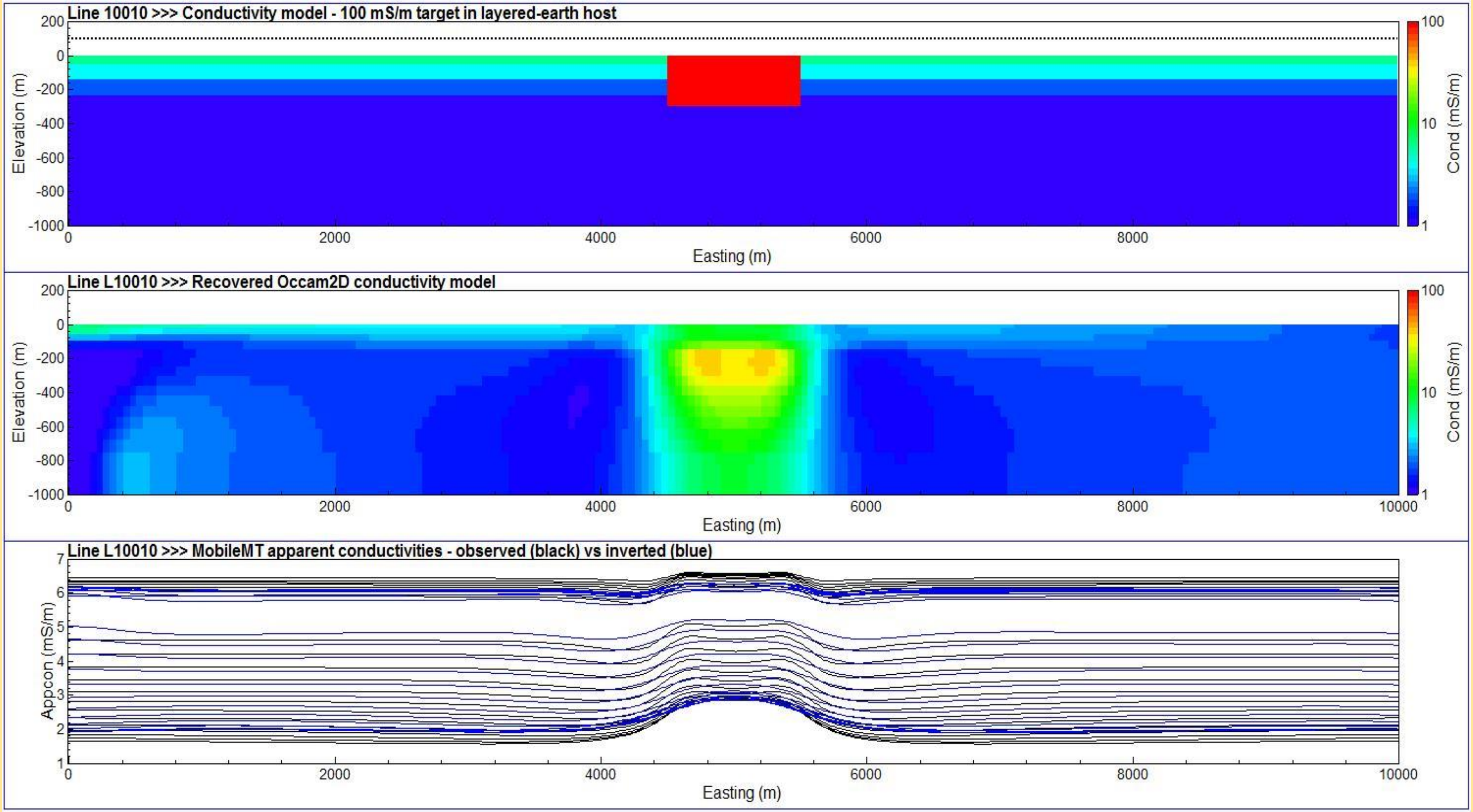


2D synthetic MobileMT data modeling

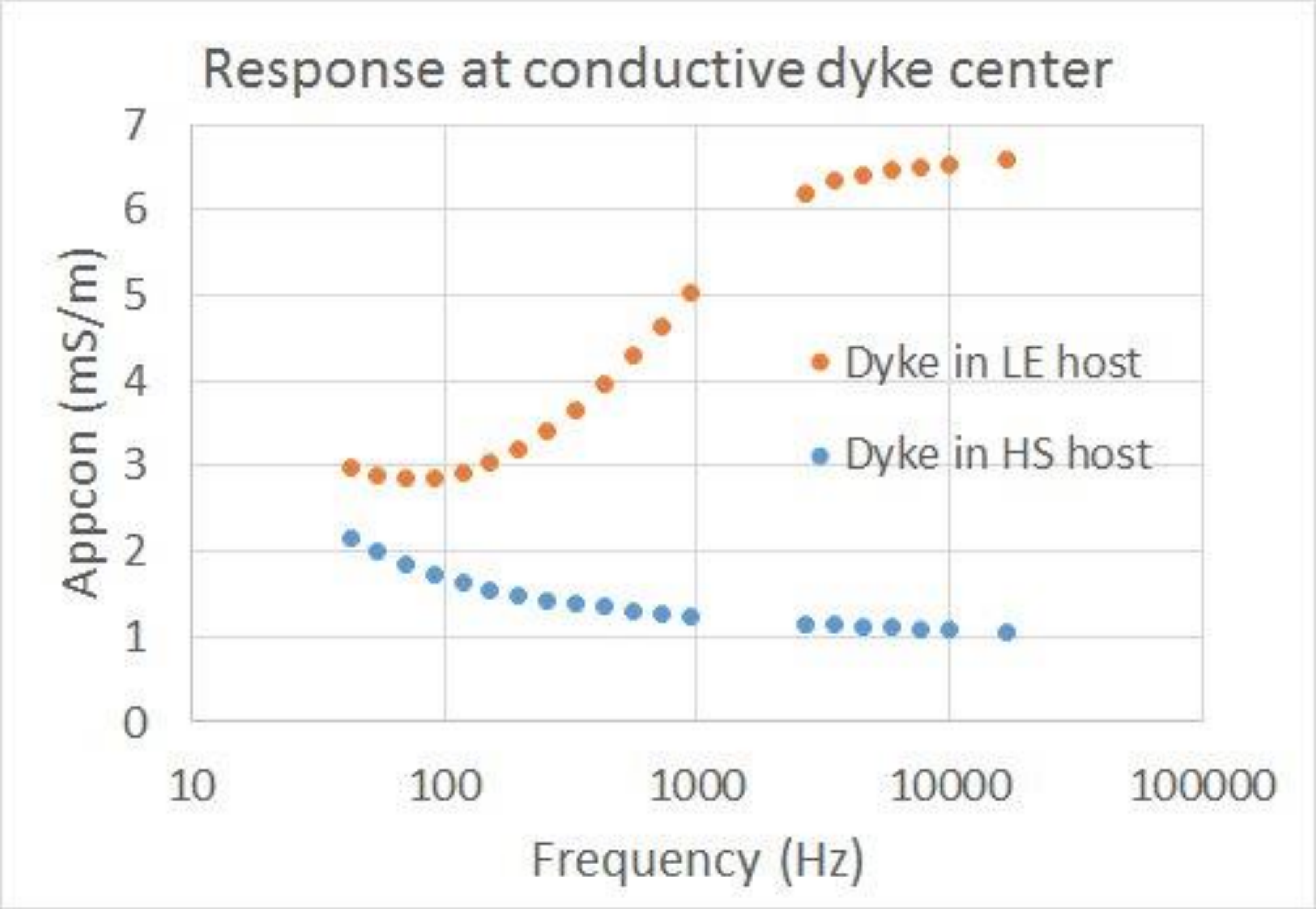


Non-zero response over layered-earth!

2D synthetic MobileMT data inversion

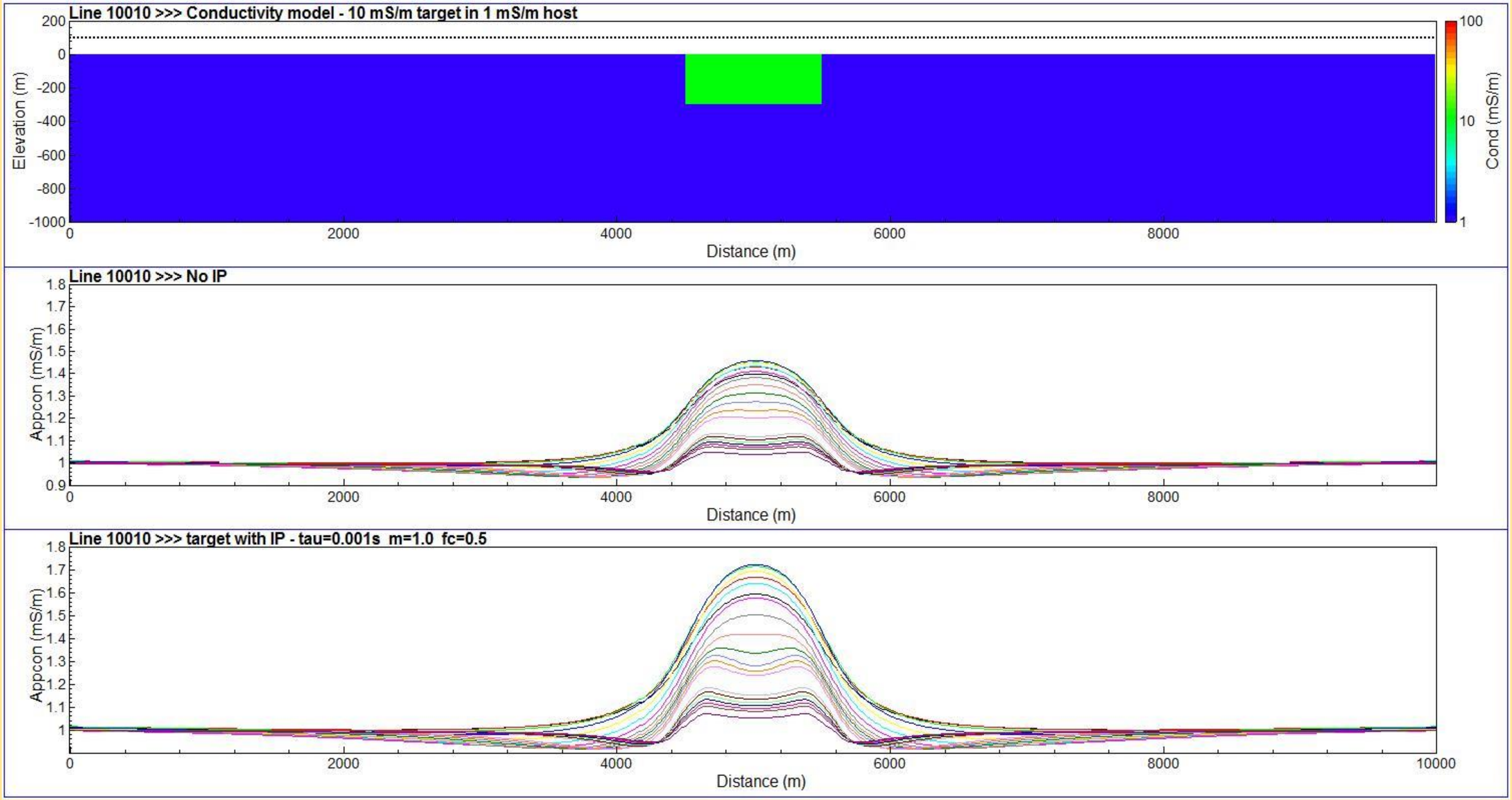


2D synthetic MobileMT data inversion



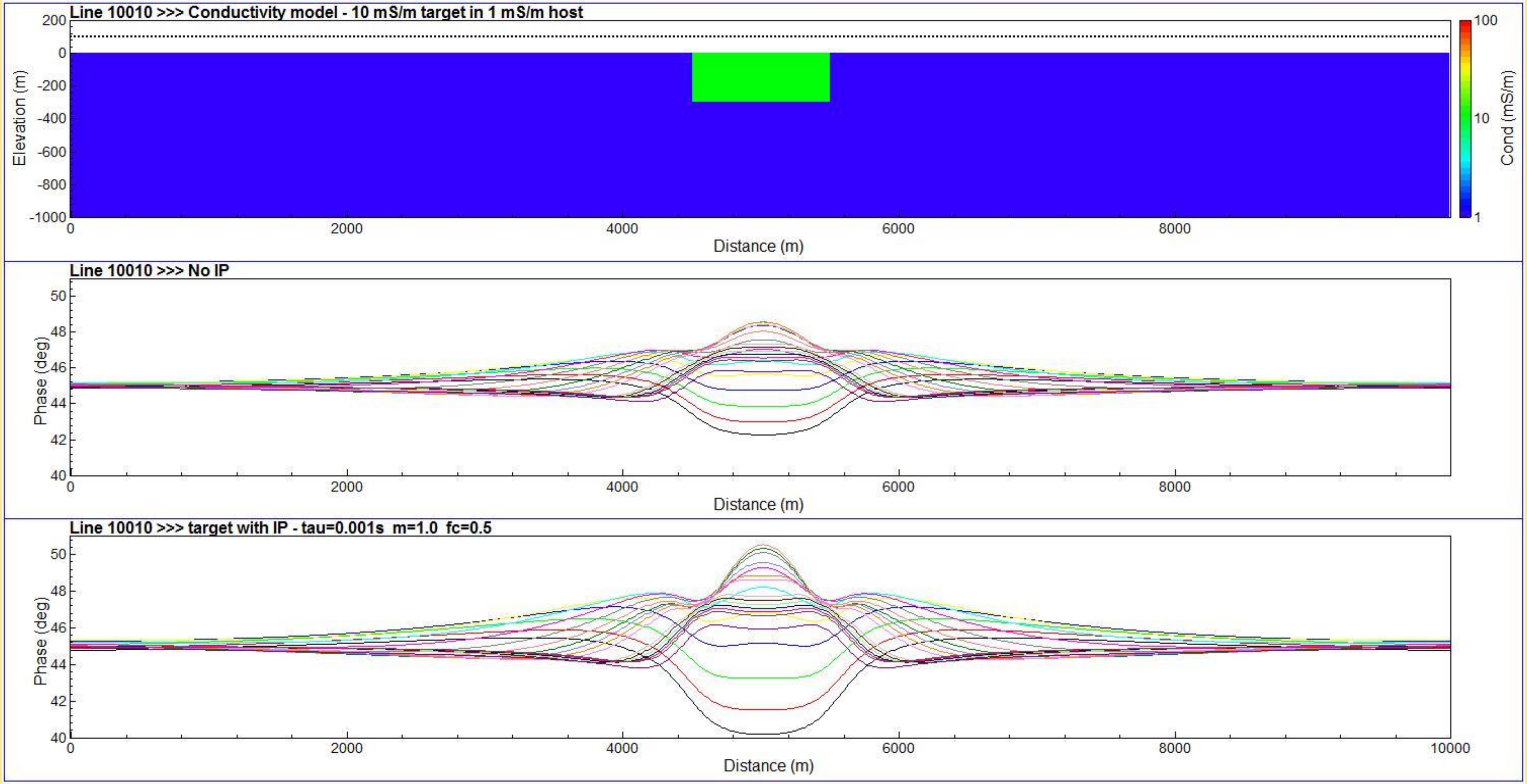
2D synthetic MobileMT data modeling - appcon

Target without/with IP - tau=0.001s m=1.0 fc=0.5

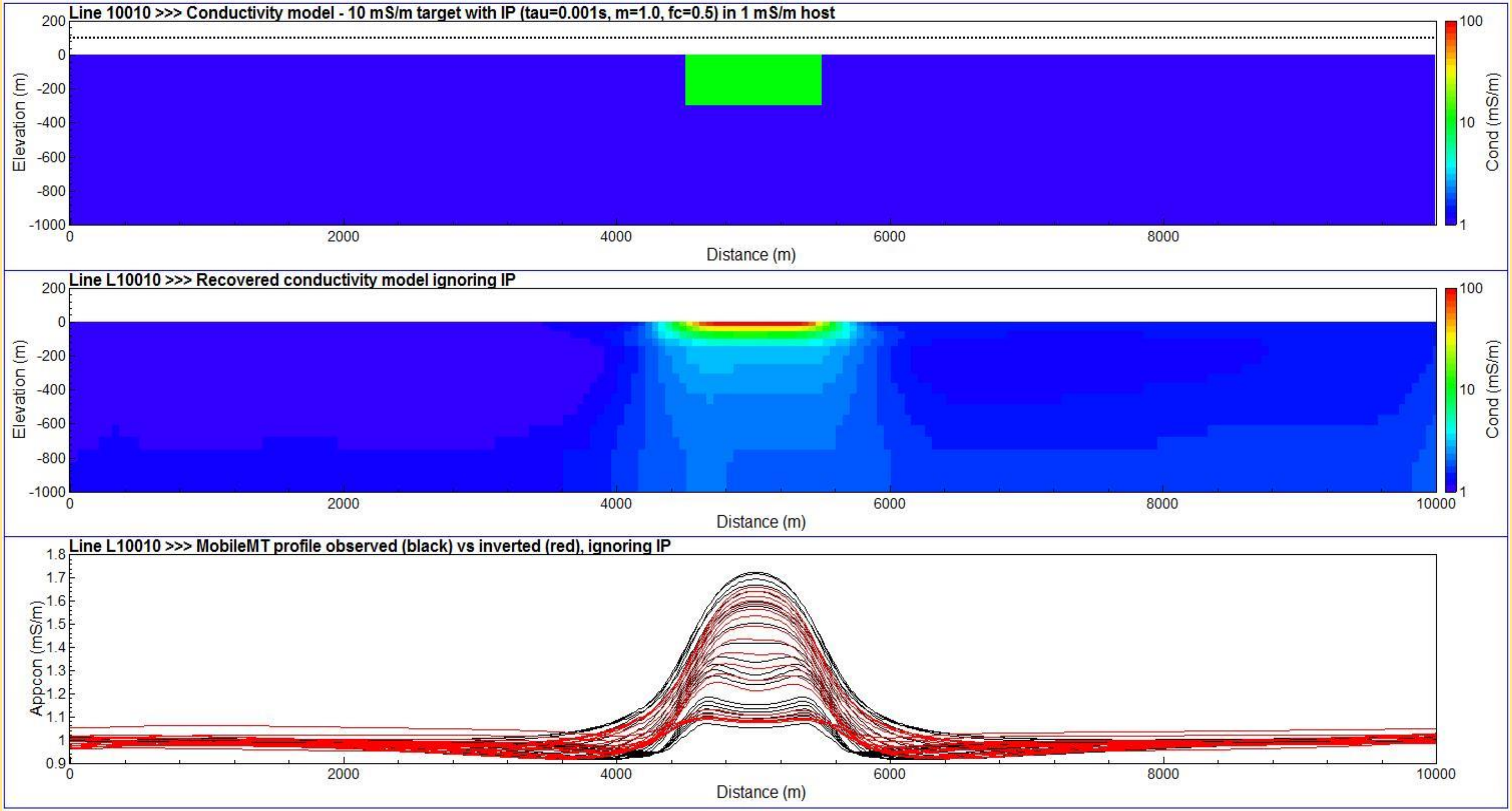


2D synthetic MobileMT data modeling – phase

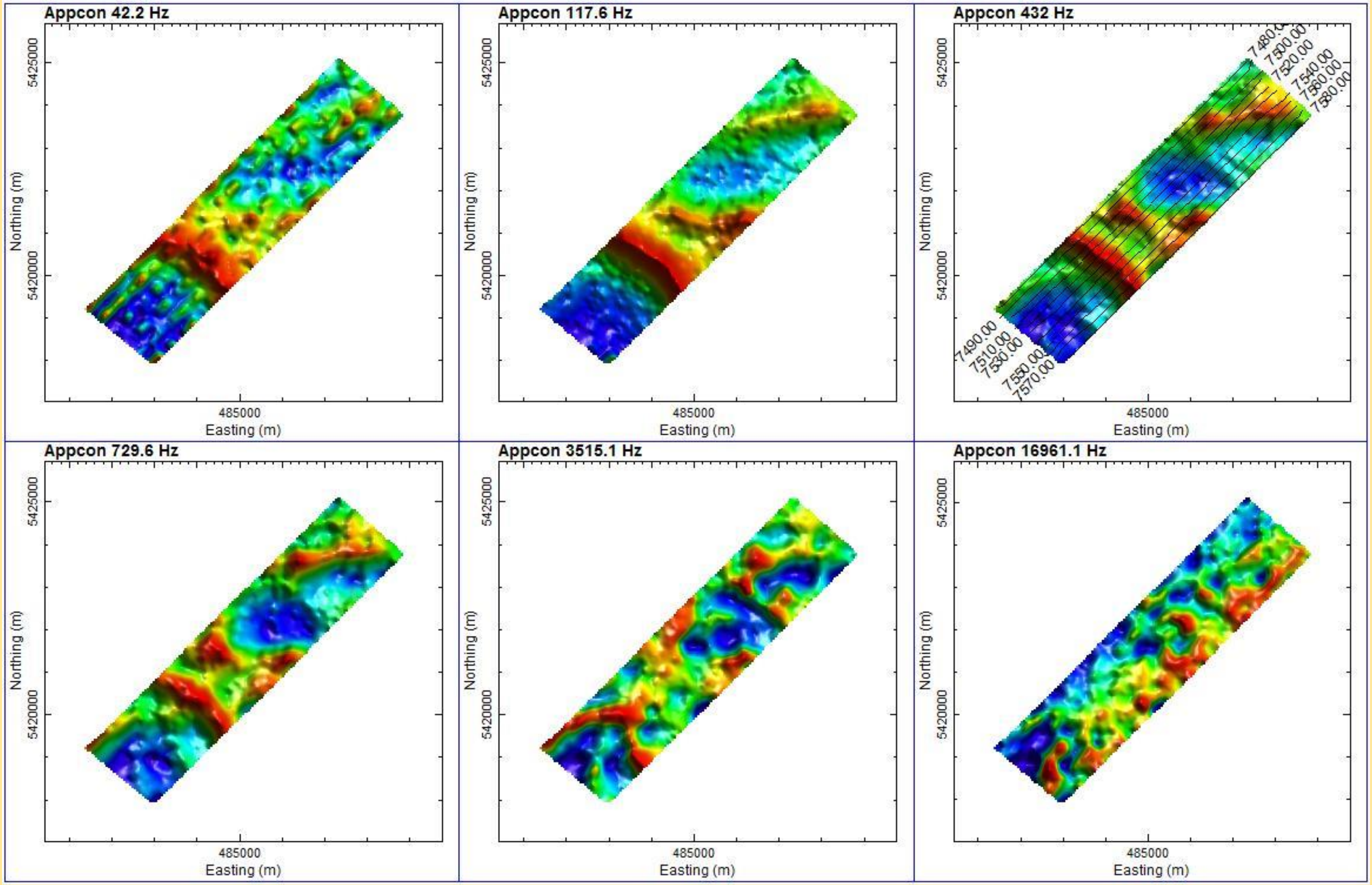
Target without/with IP - tau=0.001s m=1.0 fc=0.5



2D synthetic MobileMT data inversion, ignoring IP



MobileMT survey – VMS exploration, N Ontario
Apparent conductivities

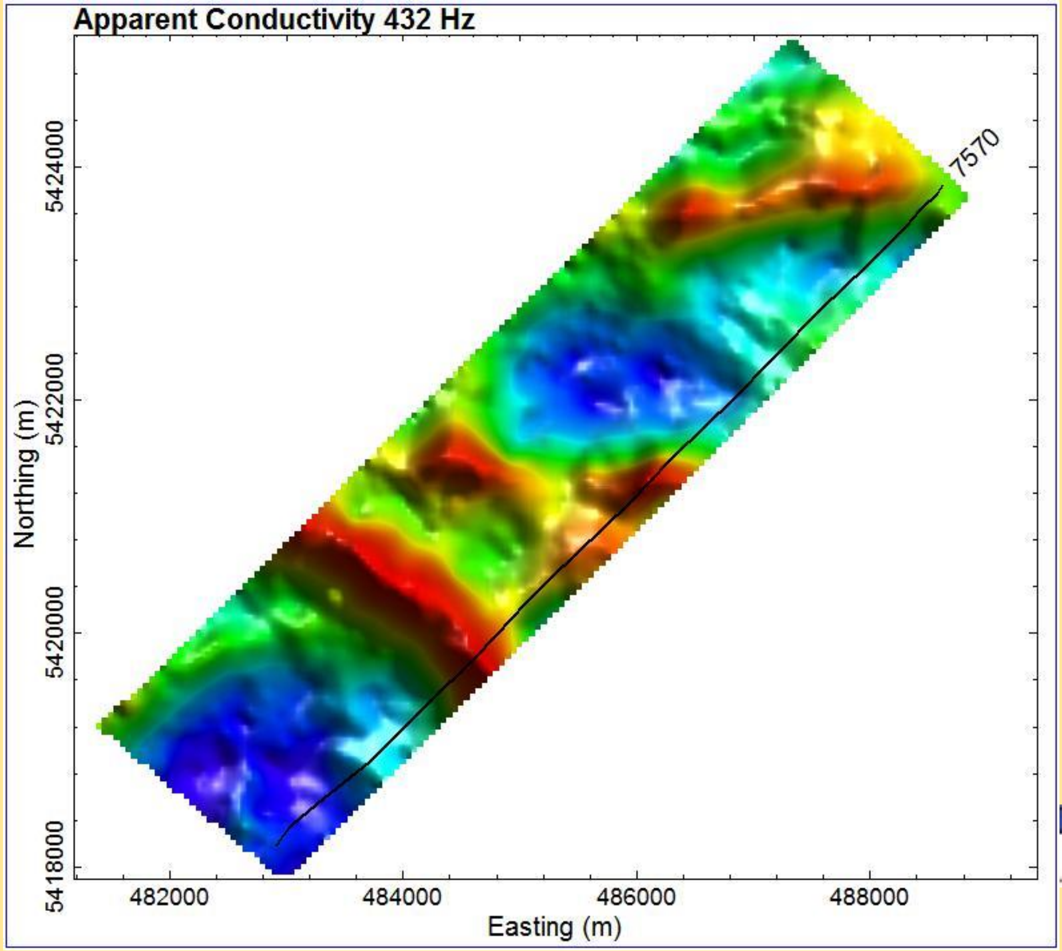


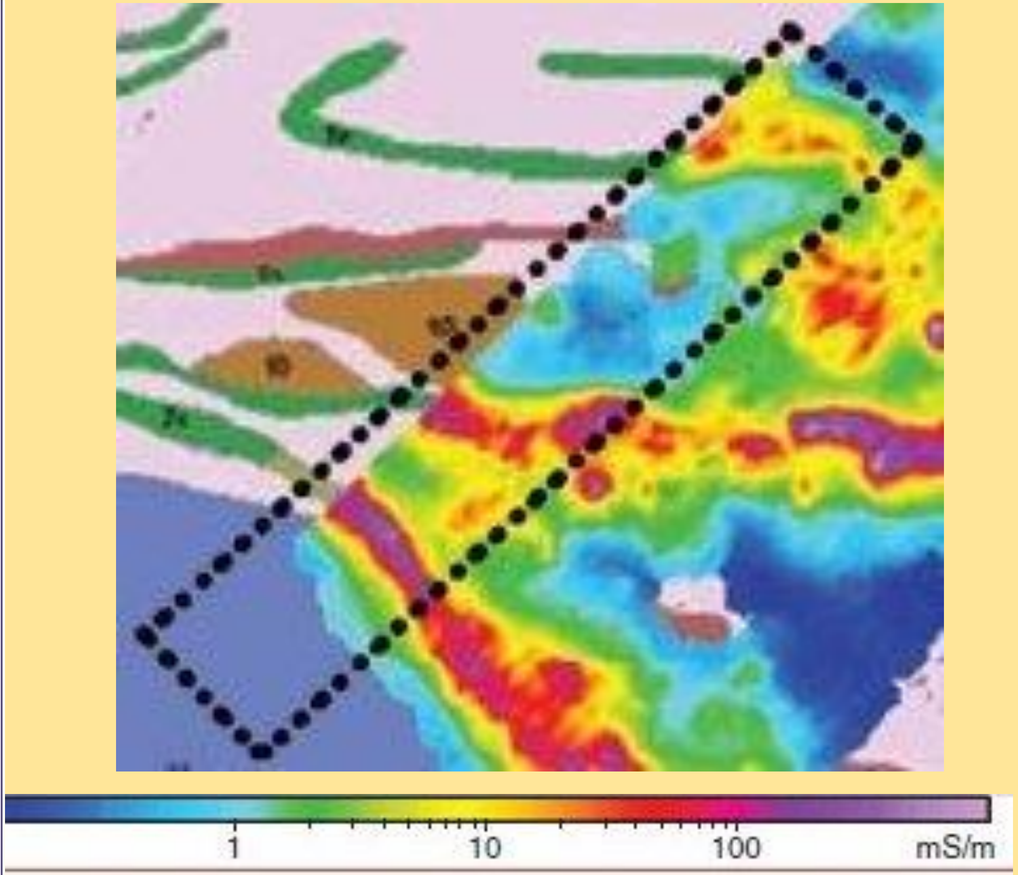
VTEM

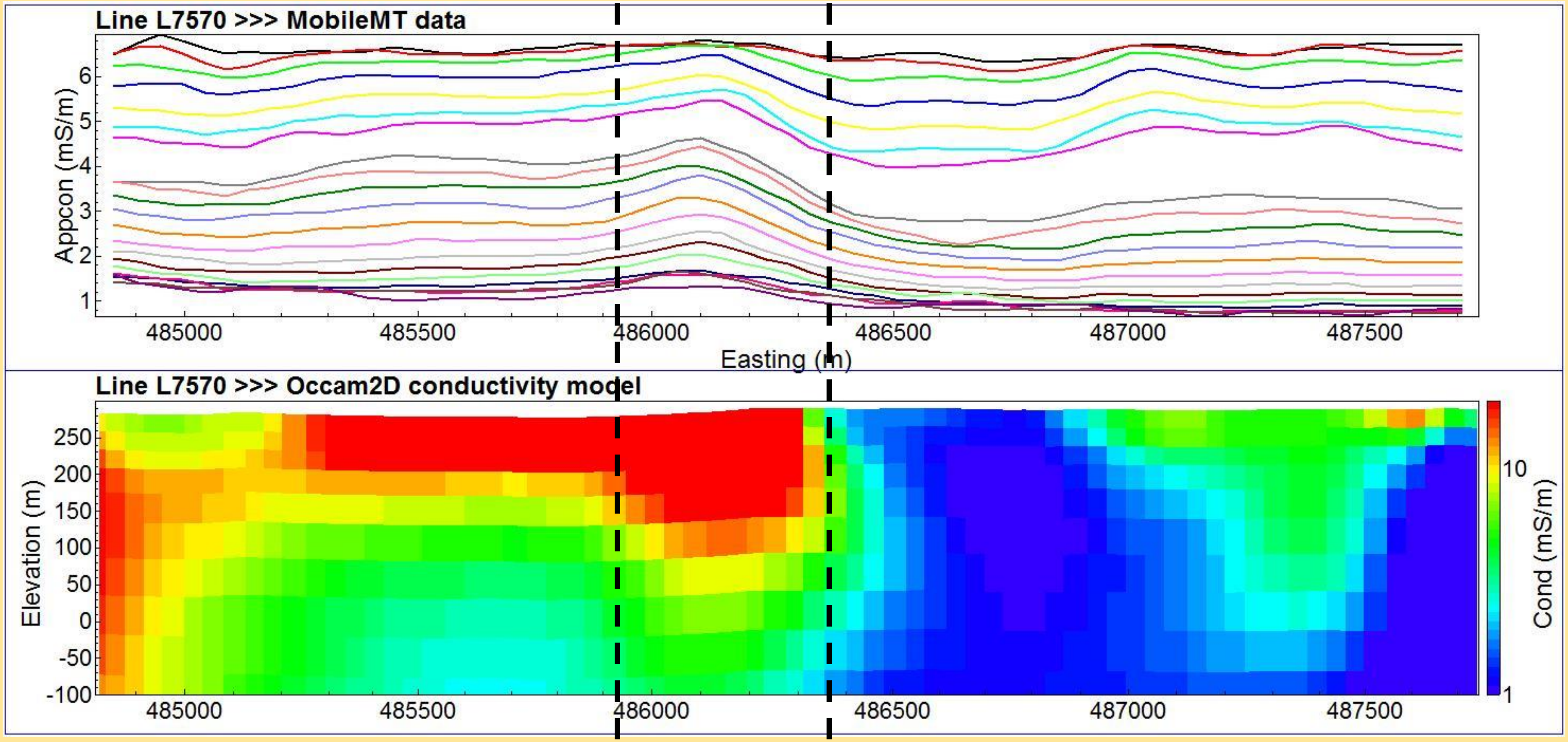
MobileMT

Con at 150 m depth

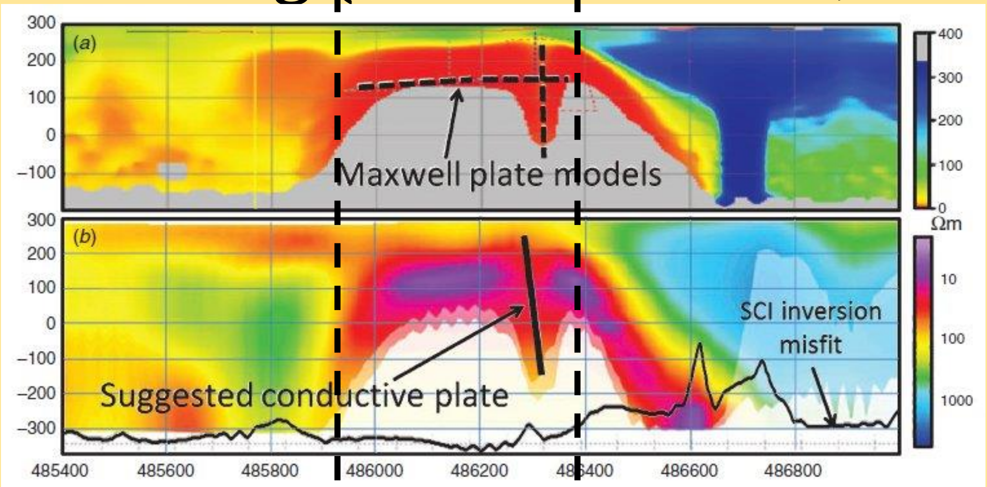
(Kaminski et al., 2016)



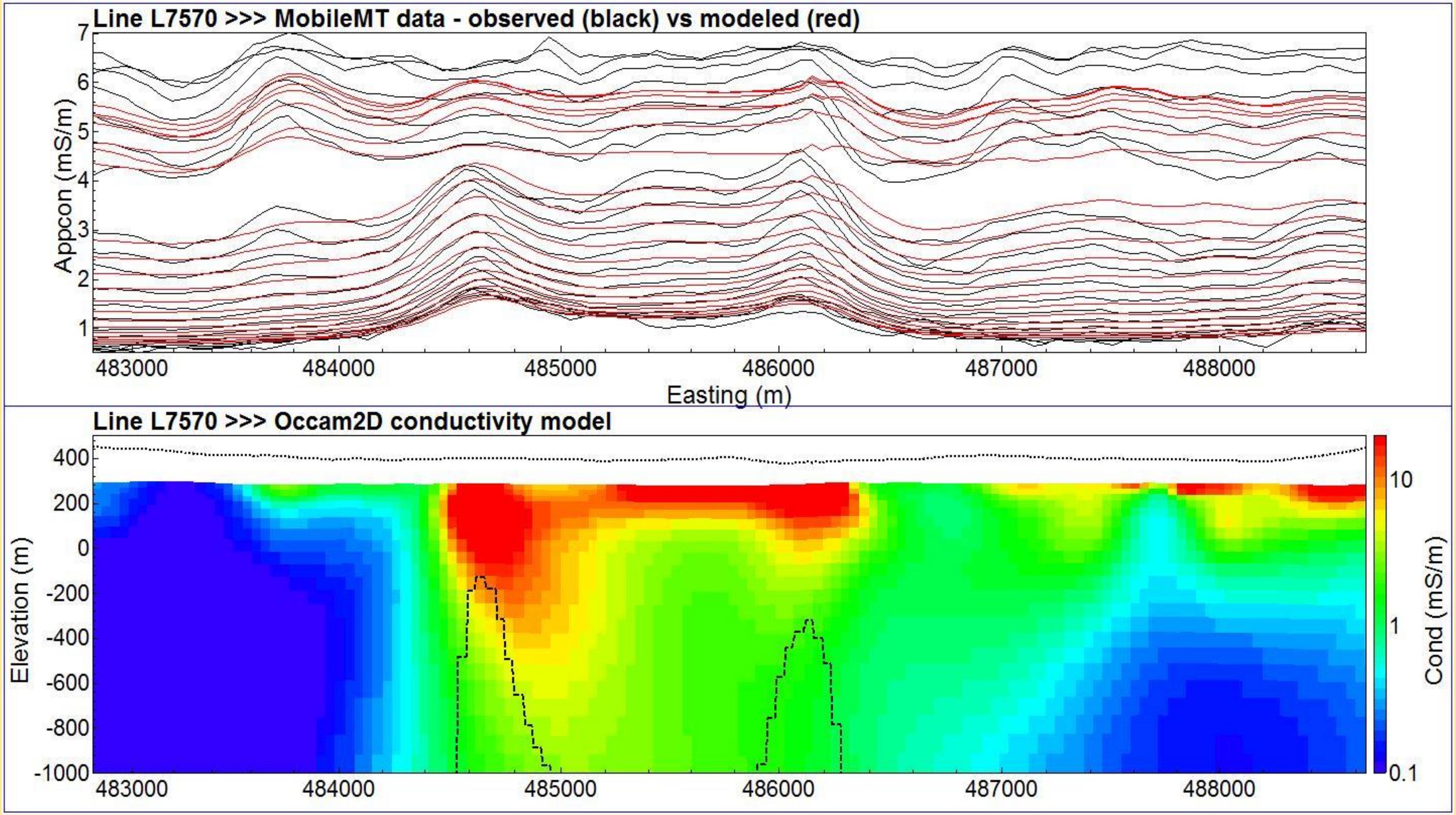




VTEM data modeling (Kaminski et al., 2016):



Occam2D inversion results



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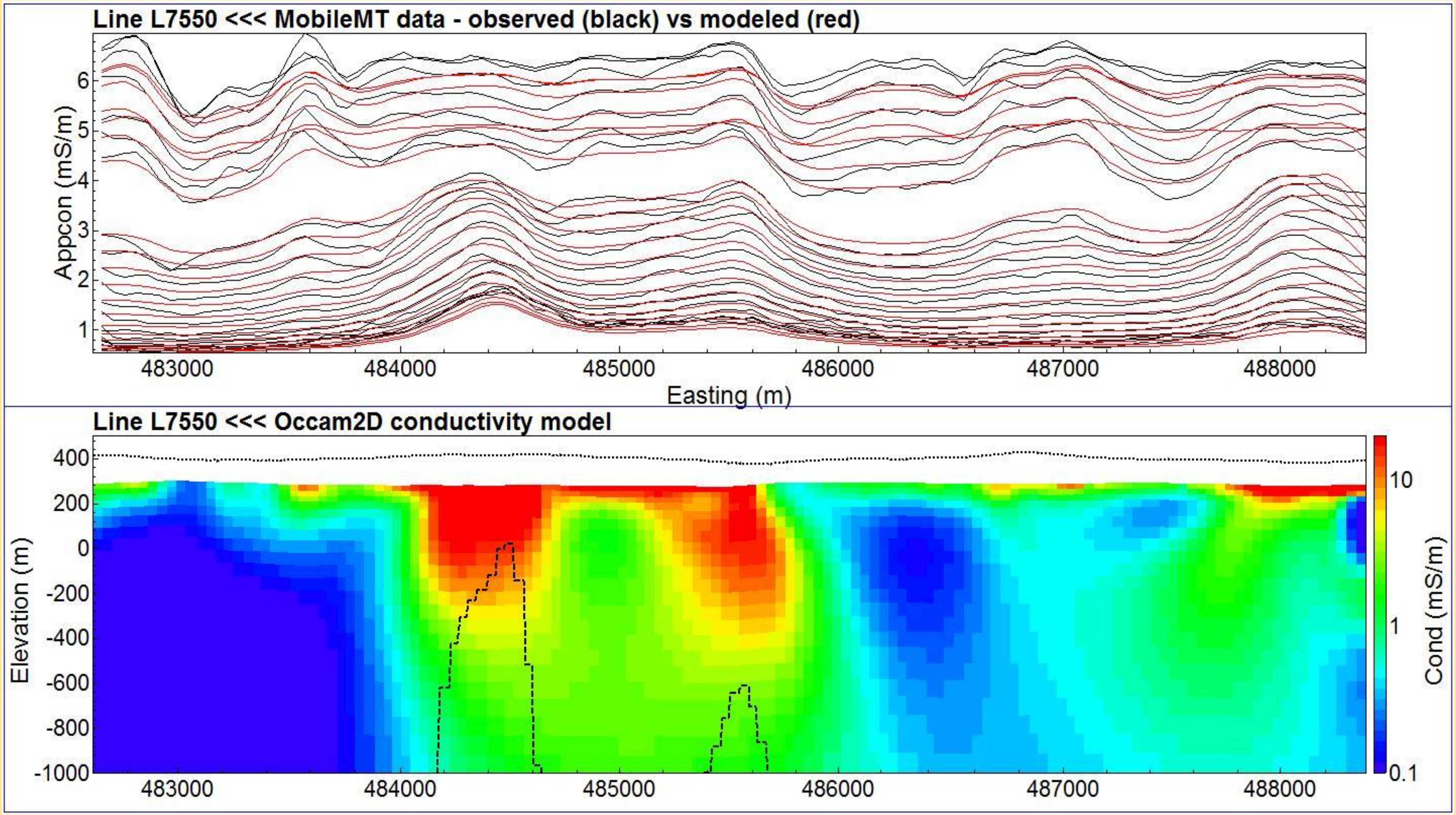

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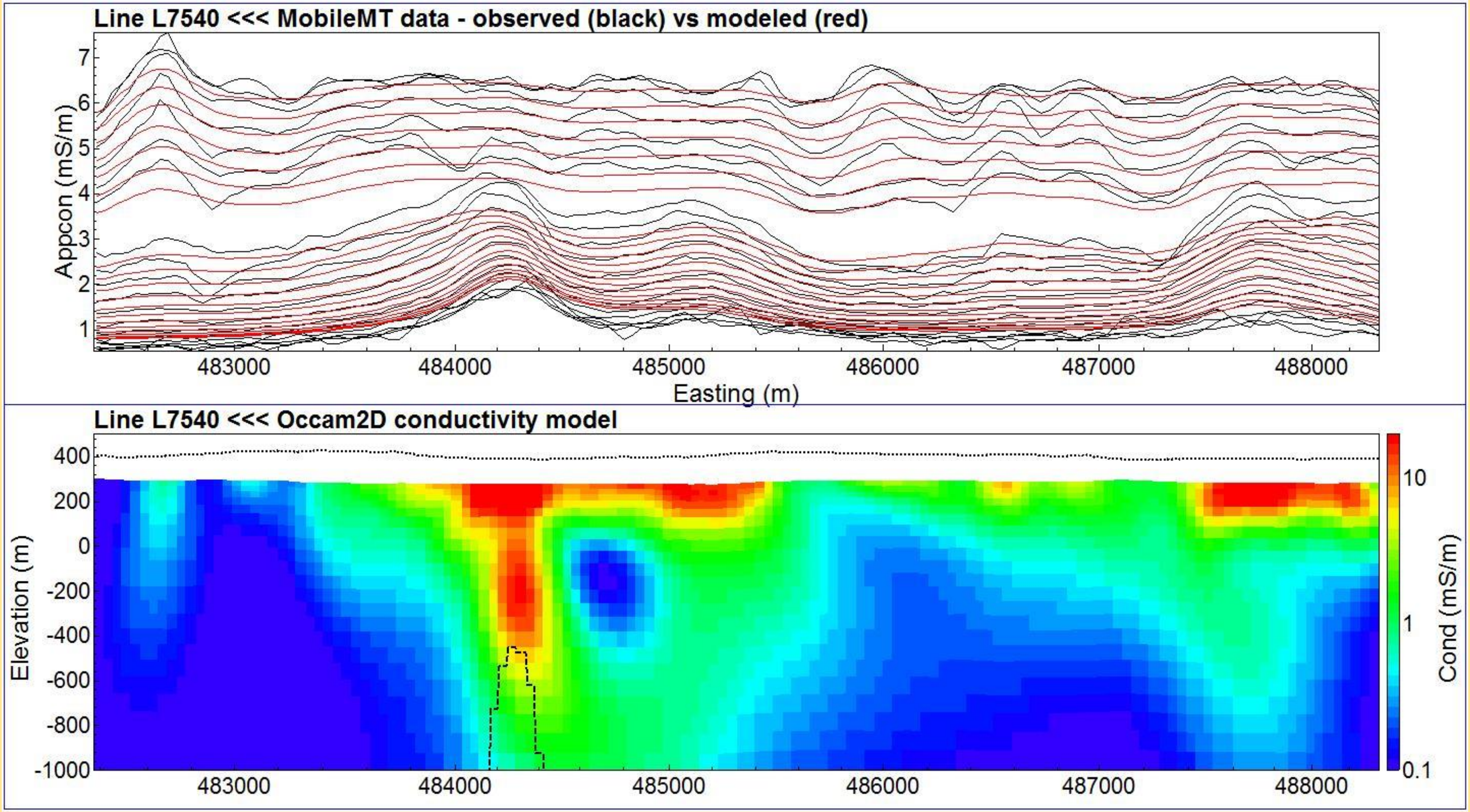
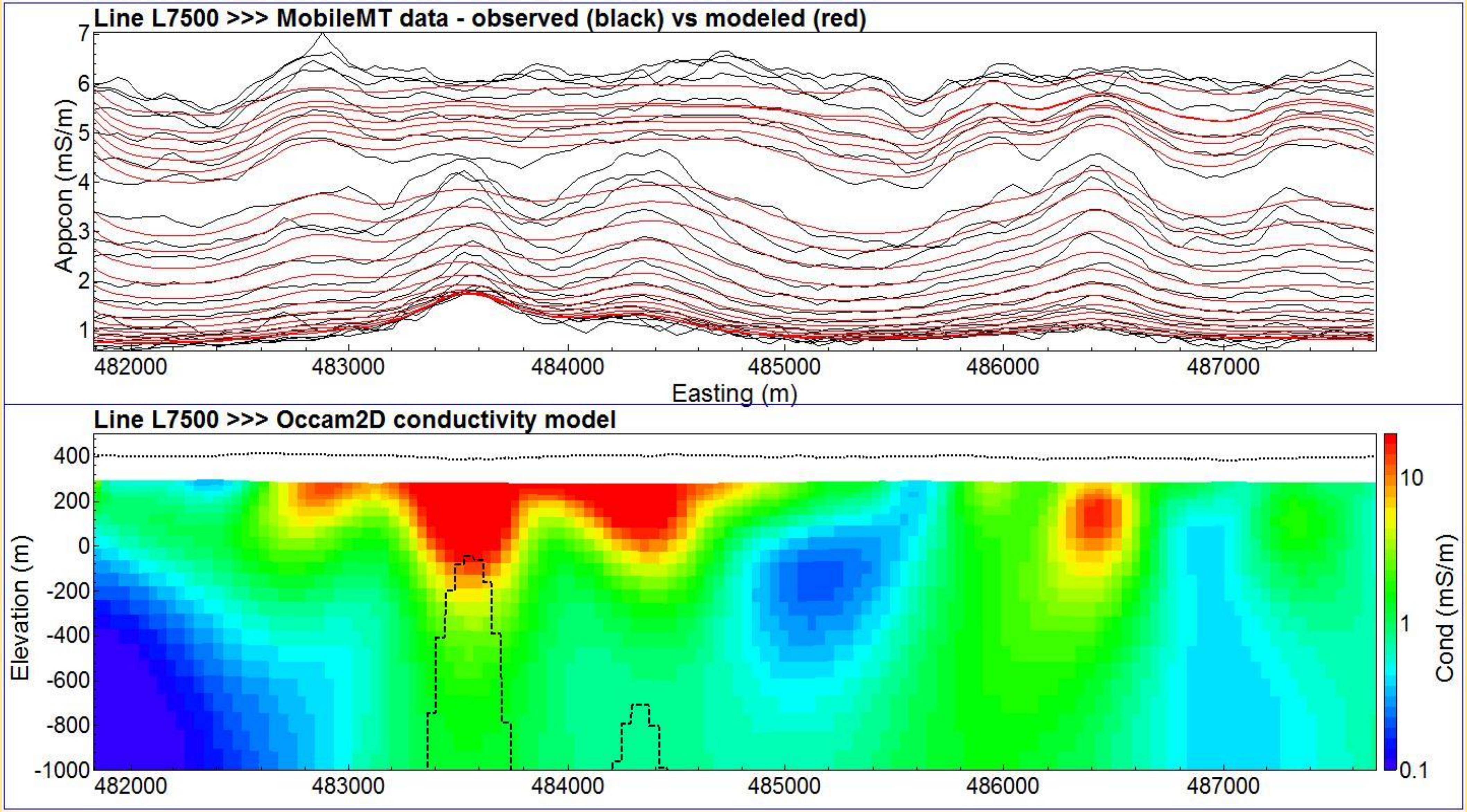


Occam2D inversion results



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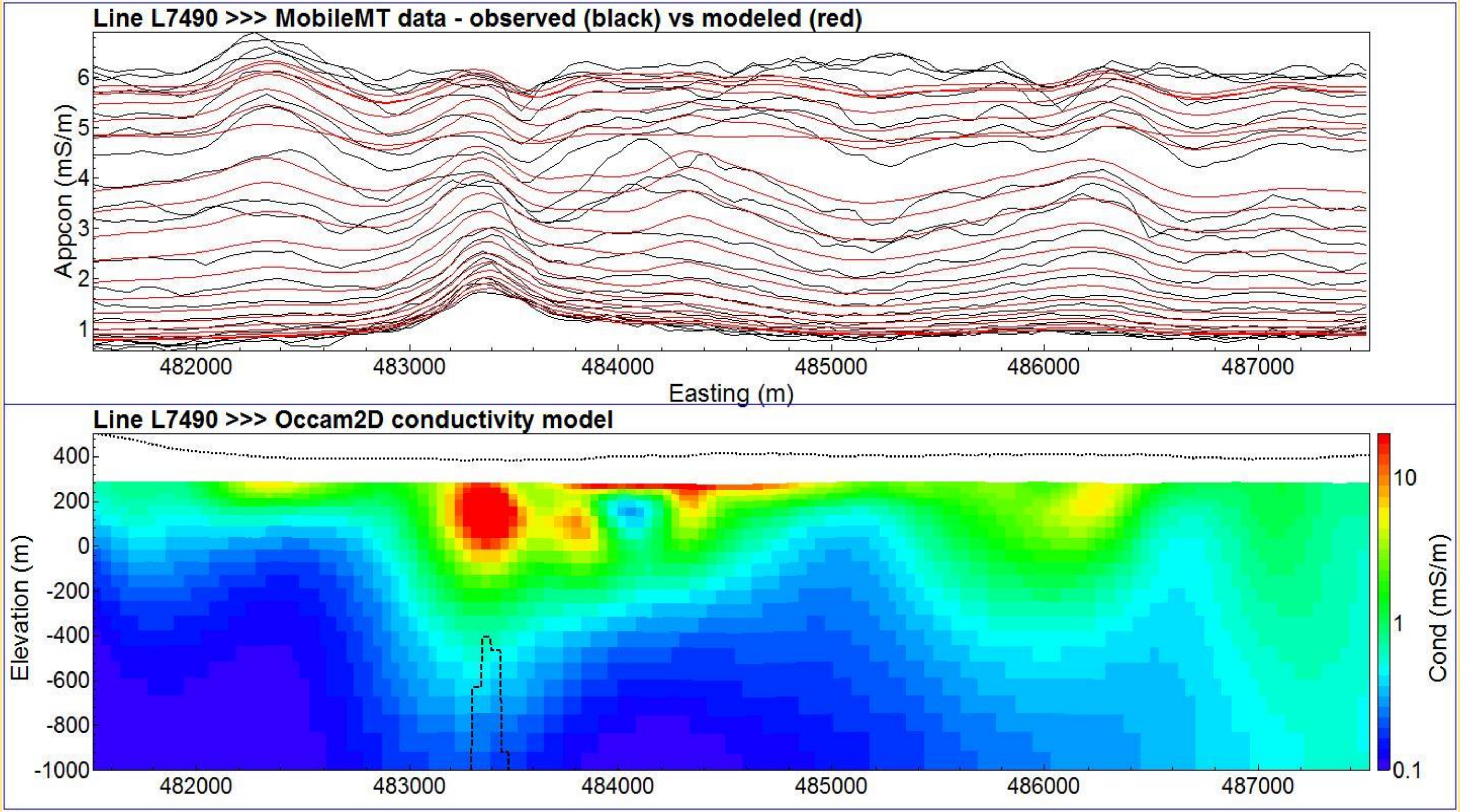
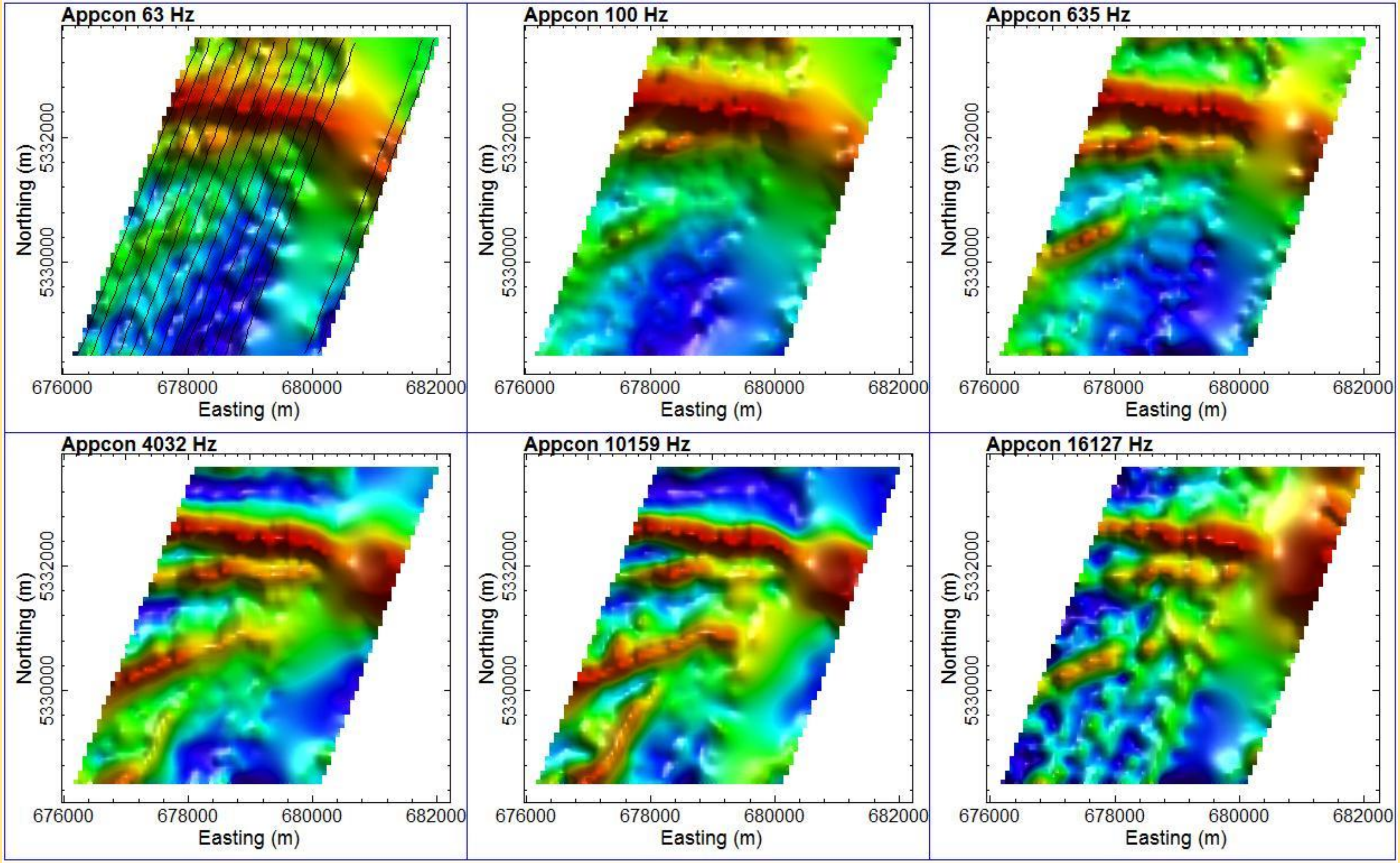
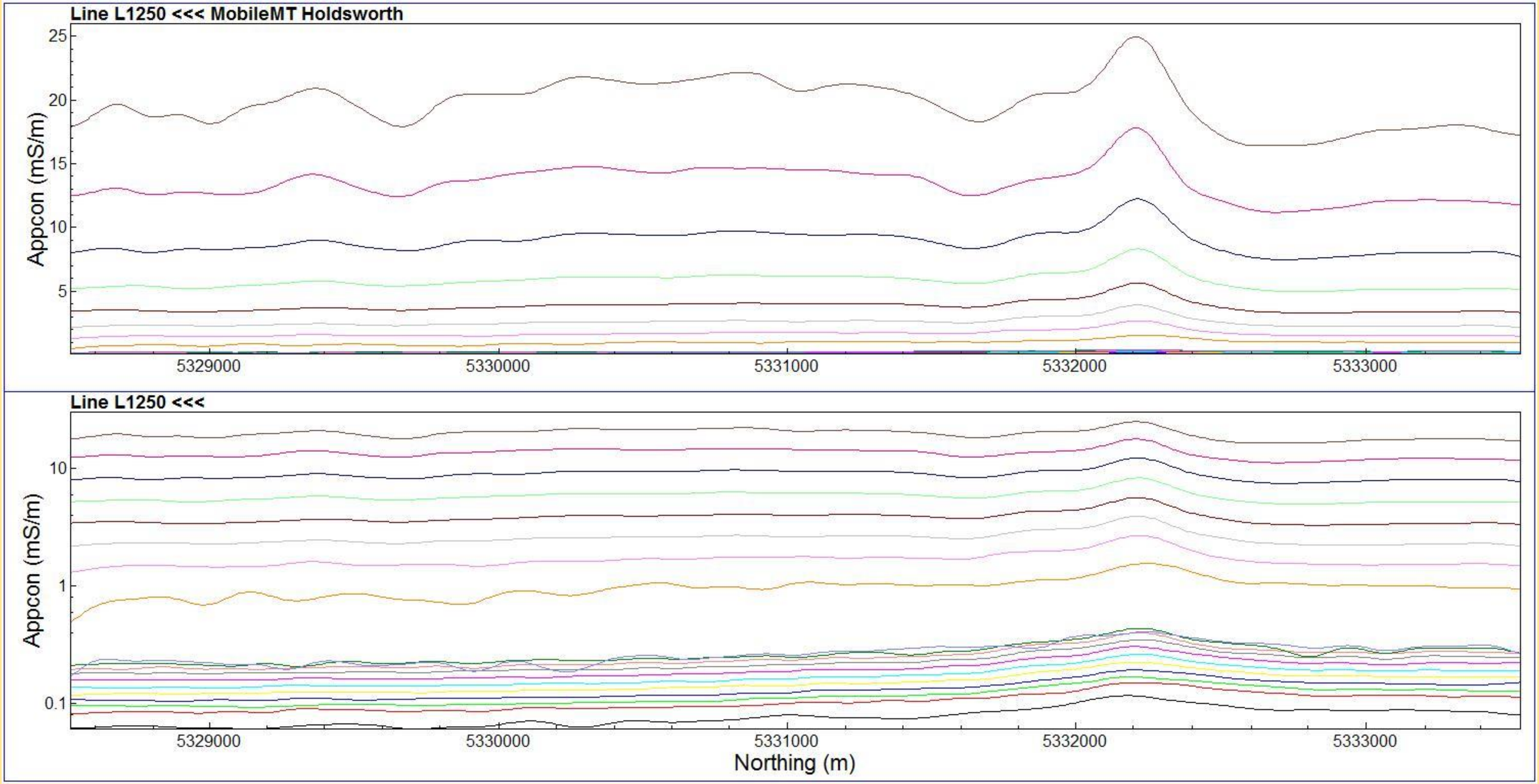


Holdsworth Gold project, N Ontario

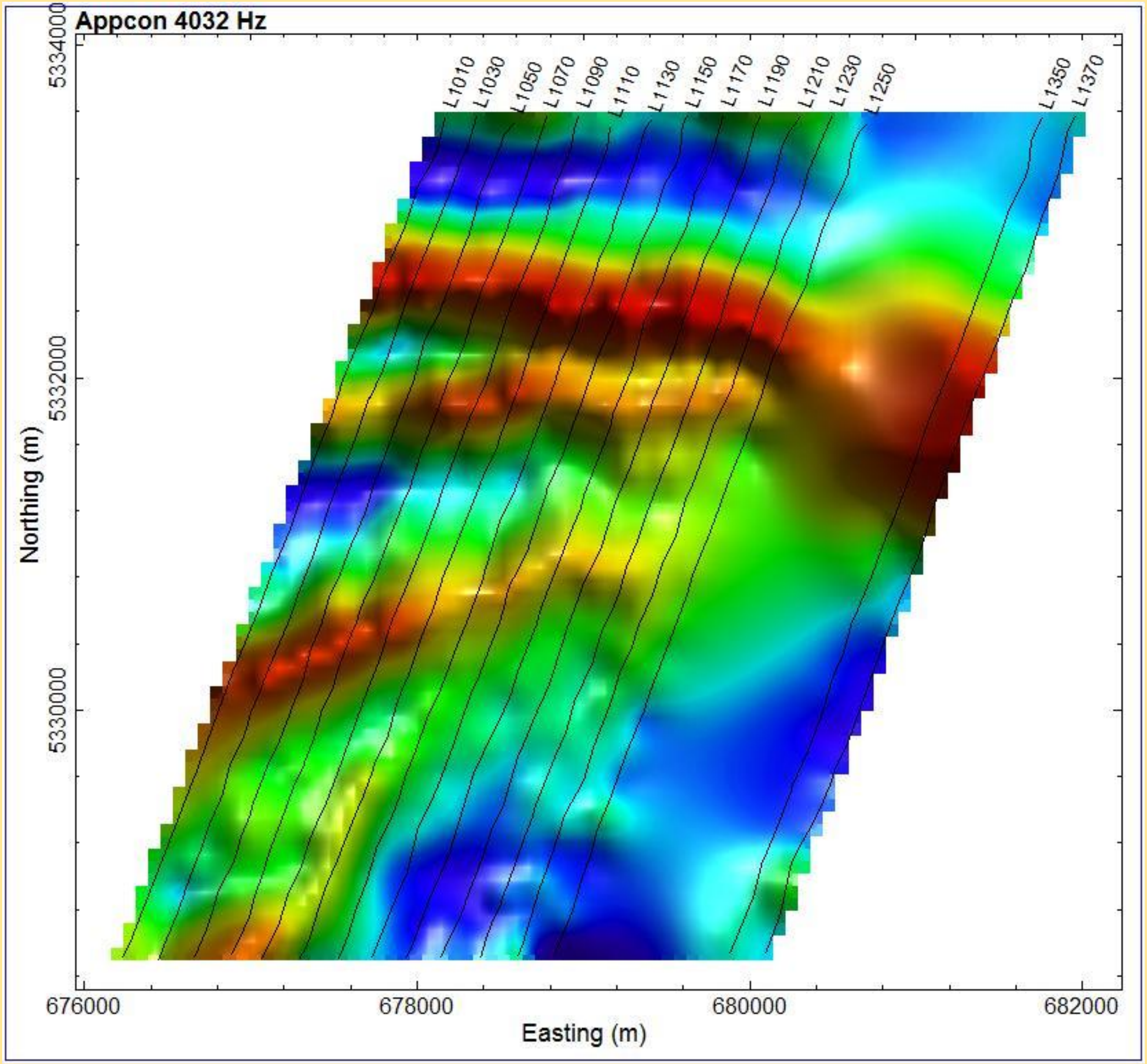
Structural mapping - shear-zones, quartz veins

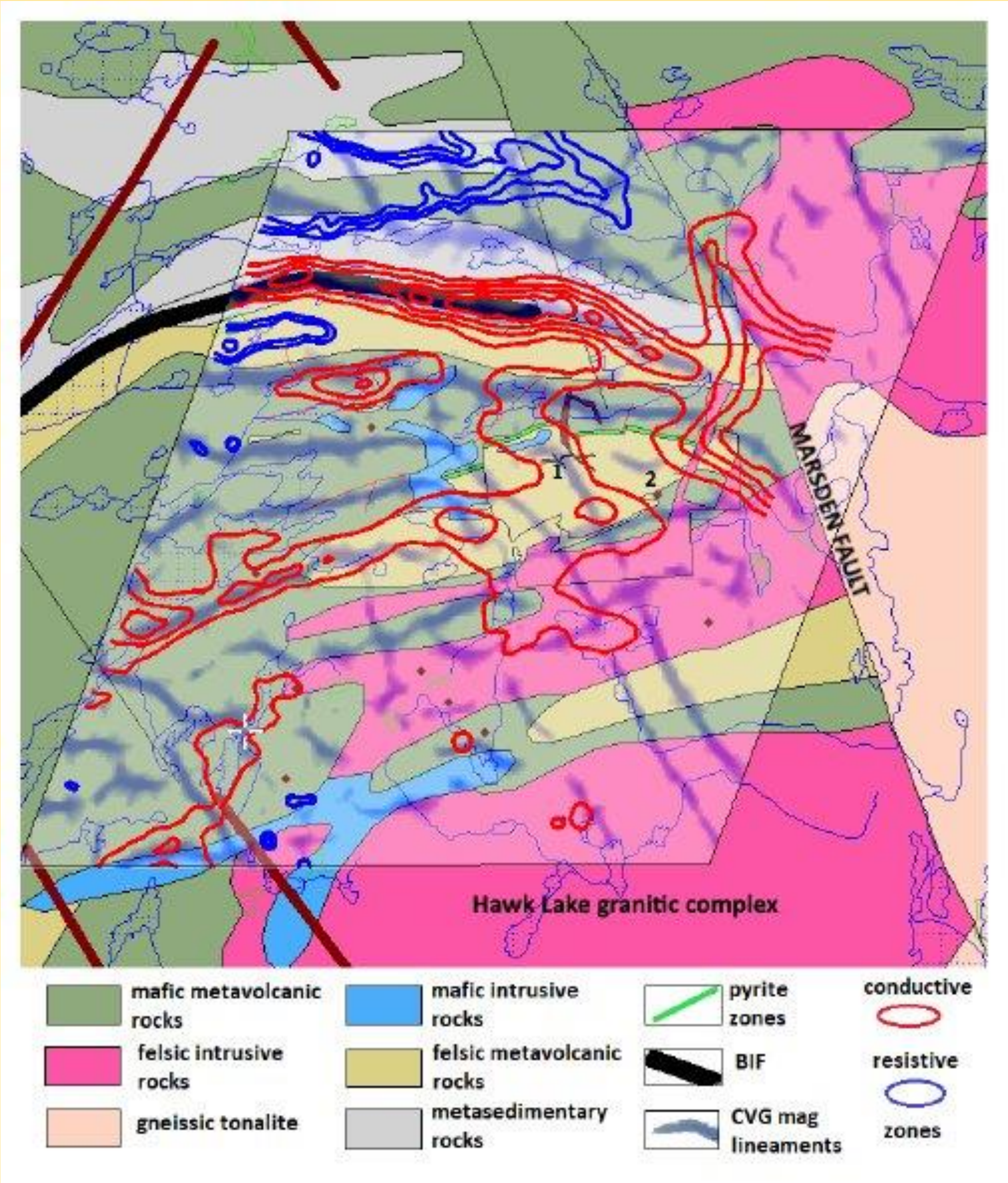


Holdsworth project



Holdsworth project





MobileMT appcon vs ZTEM tipper data

Pros:

- Extending frequency nice, though not critical
- dBx/dt & dBy/dt stronger signal than dBz/dt, requiring smaller Rx coils (1.4 m) than ZTEM (7.4 m)
- combination of H/E-fields makes data sensitive to resistivity values (eg LE), rather than resistivity contrasts

Cons:

- being more sensitive to local resistivities makes modeling harder (start model!)
- harder to collect good E-field data in rocky/sandy/frozen terrain?

Acknowledgements

Expert Geophysics Limited

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