

Carbonatite melt pathways connect the deep mantle to Archean craton margins

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Supplementary Section

Data

A database of 200 long-period (10-10000 s) MT responses was established from a combination of new AuLAMP sites and legacy data that cover an area of 800 km by 800 km, with a typical site spacing of 55 km. Figure S1 shows apparent resistivity and phase invariants at periods of 21 s, 215 s and 2154 s. Phase tensors for the same periods are shown in the main paper Fig. 2.

Fig. S2 shows the real part of the vertical transfer functions T_{zx} and T_{zy} for periods of 46, 464 and 4642 s. For T_{zx} , the red regions correspond to a component of induction arrow (in the Parkinson convention) pointing geographic north; blue regions are for an arrow direction to the south. For the T_{zy} component, the convention would be that red regions are for arrows pointing towards the east; blue regions are to the west.

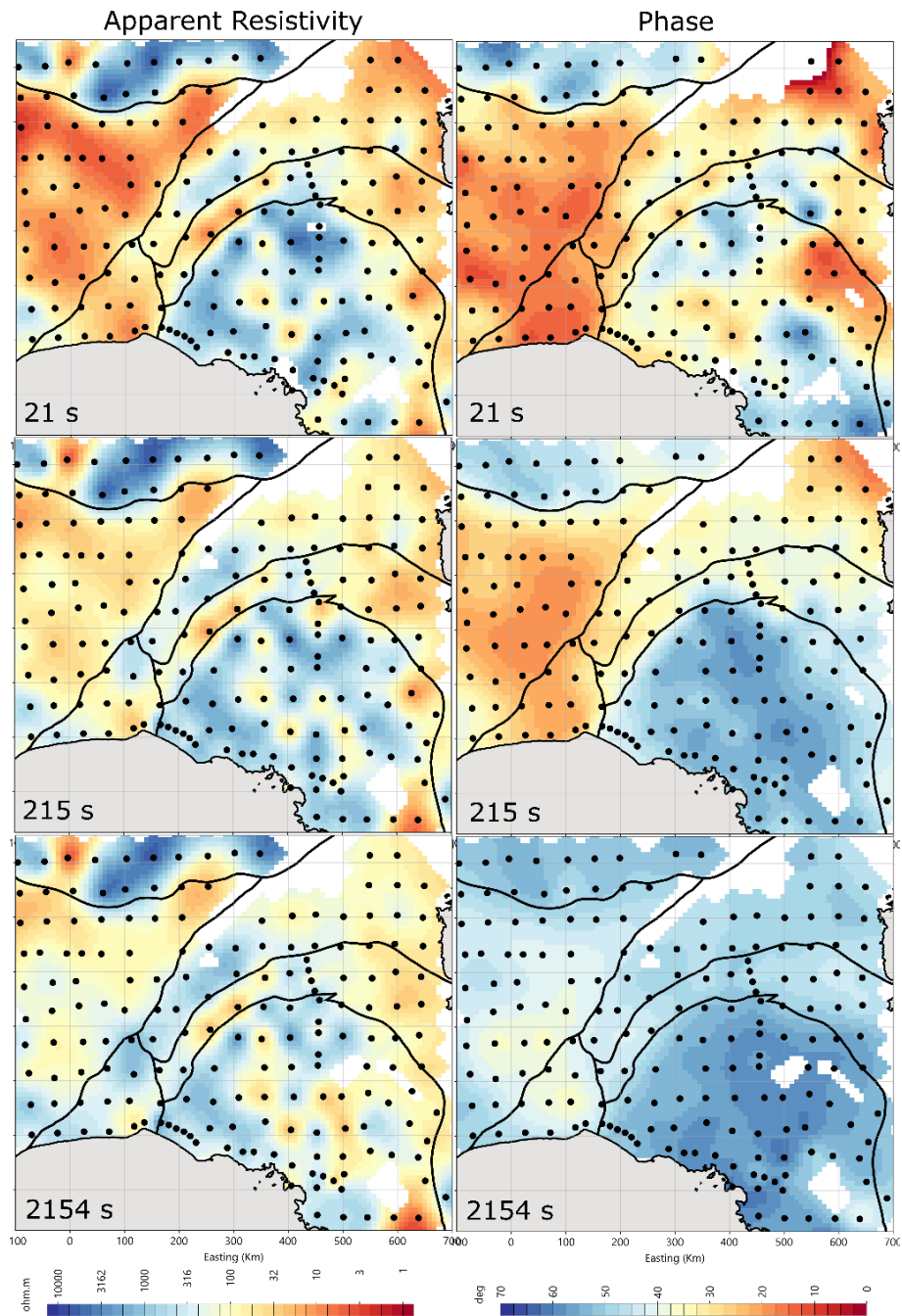


Figure S1. Apparent Resistivity and phase invariants at all long-period MT sites (black circles) for periods of 21, 215 2154 s. Thicker black lines represent major crustal boundaries. All figures were produced using Viridien Geotools v.4.0.6.12598 (<https://www.viridiengroup.com/expertise/multiphysics-imaging/geotools>) and Inkscape v1.2.1 (<https://inkscape.org>).

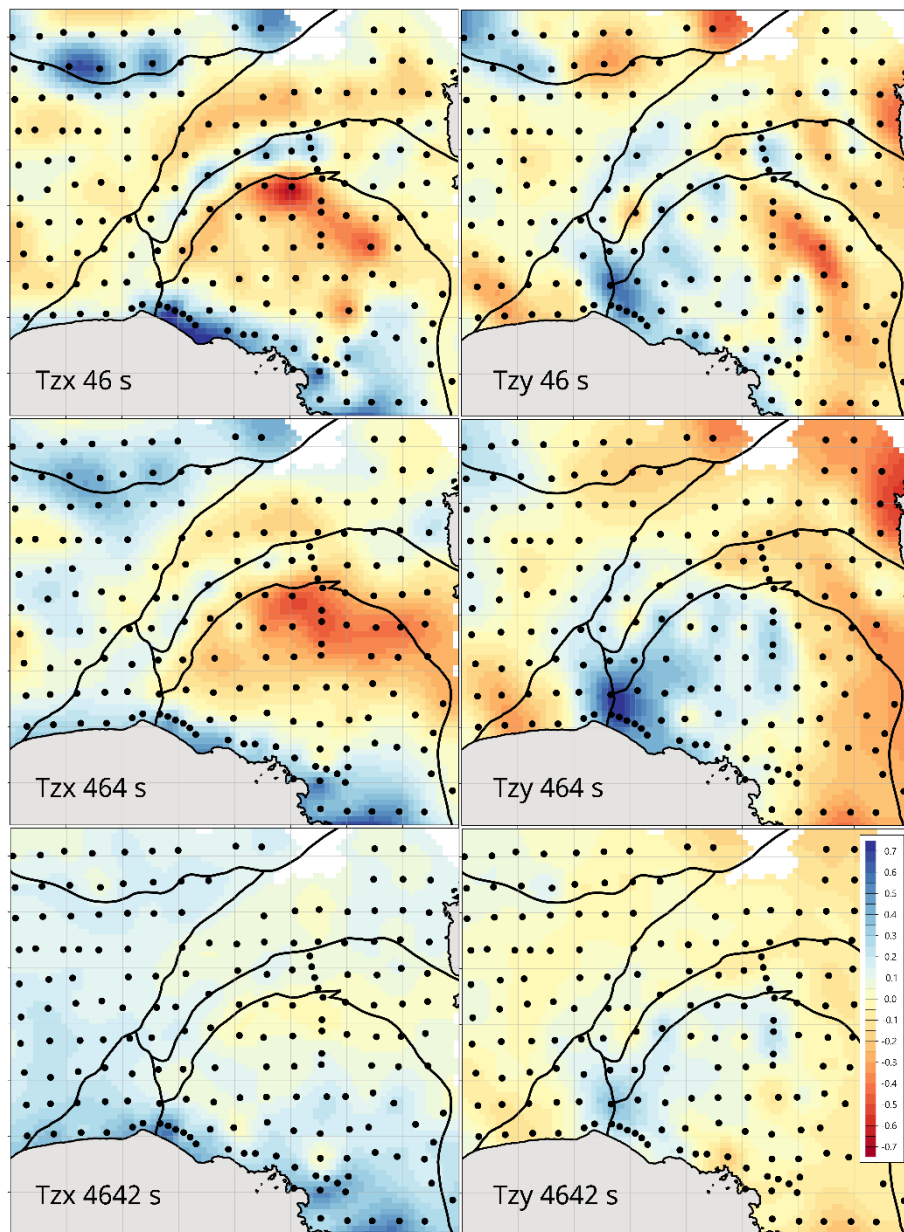
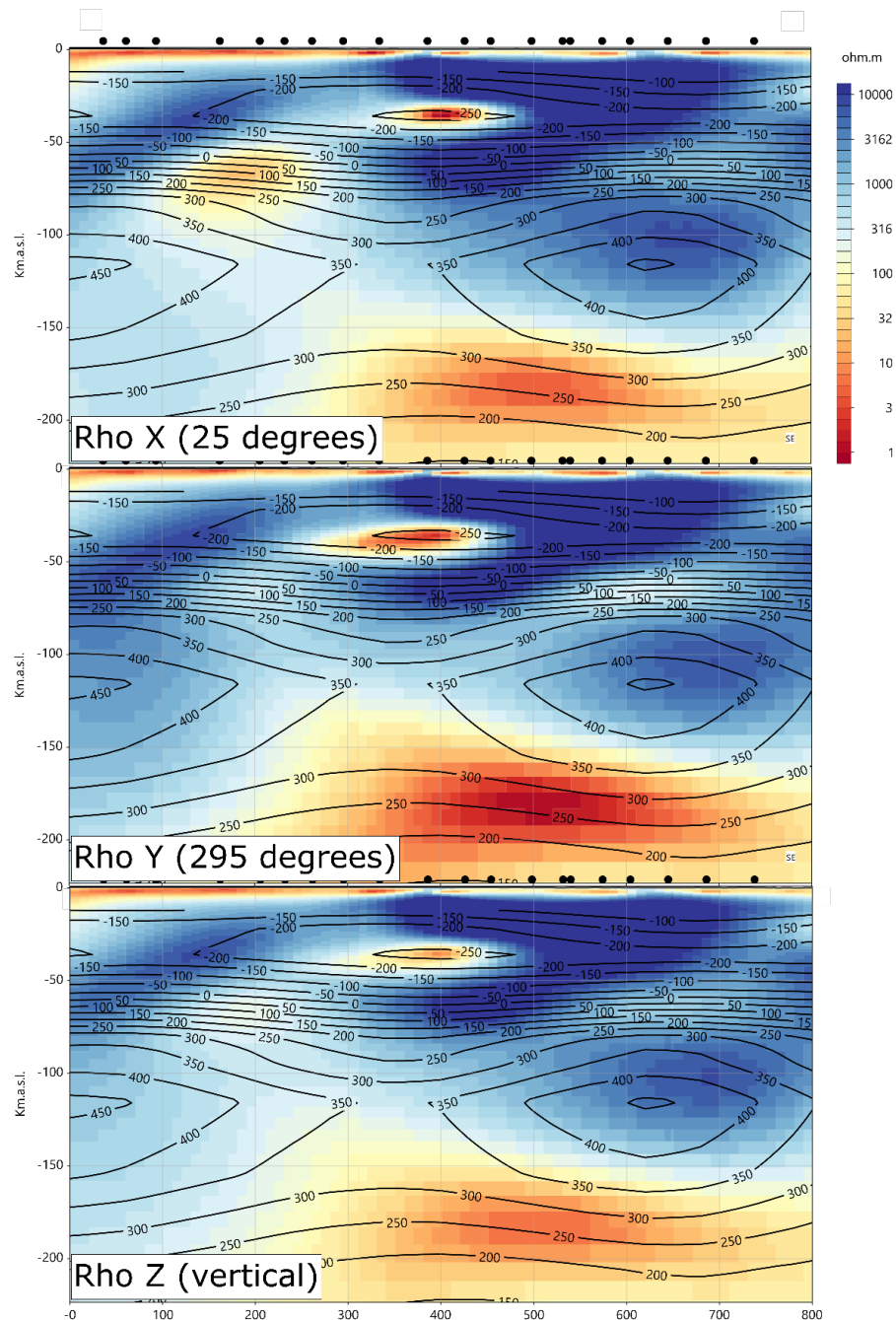


Figure S2. Vertical field transfer functions for periods of 46, 464 and 4,642 s at all long-period MT sites (black circles). Only the real (in phase) component are shown, typically the imaginary (out of phase) components are smaller. Thicker black lines represent major crustal boundaries. All figures were produced using Viridien Geotools v.4.0.6.12598 (<https://www.viridiengroup.com/expertise/multiphysics-imaging/geotools>) and Inkscape v1.2.1 (<https://inkscape.org>).

37 **Anisotropic Model**

38 In the main paper we show in Fig 4a the cross section for a profile across the margin and
39 central component of the Gawler Craton. In Fig, S3 the anisotropic model is shown for
40 the same profile, along with contours of velocity variations from a reference model.



41
42 **Figure S3.** Cross sections (Figure 4a in the main paper) for the anisotropic model, with
43 X being orthogonal to the section; Y being parallel to the section; Z being vertical. All
44 figures were produced using Viridien Geotools v.4.0.6.12598

(<https://www.viridiengroup.com/expertise/multiphysics-imaging/geotools>) and Inkscape
v1.2.1 (<https://inkscape.org>).

Also shown in the main paper, Figure 5, are maps at 180 km of the three resistivity axes
at 180 km depth, with X being orientated 25° clockwise from geographic north, Y being
115° clockwise, and Z vertical, along with maps of horizontal anisotropy at depth so
140, 180 and 220 km. In Figure S3 we show additional ratios of anisotropic resistivity
(X/Y, X/Z and Y/Z) at depths of 120 km (mid-lithosphere), 180 (lower lithosphere) and 240
km (asthenosphere).

A positive ratio of more than 1, and up to a factor of 10, implies the numerator is larger
than the denominator; similarly, a ratio < 1 has the numerator less than denominator.
The figures indicate that the ratio of X/Z ~ 1 at all depths, and that most significant
anisotropy is between the two horizontal and orthogonal components.

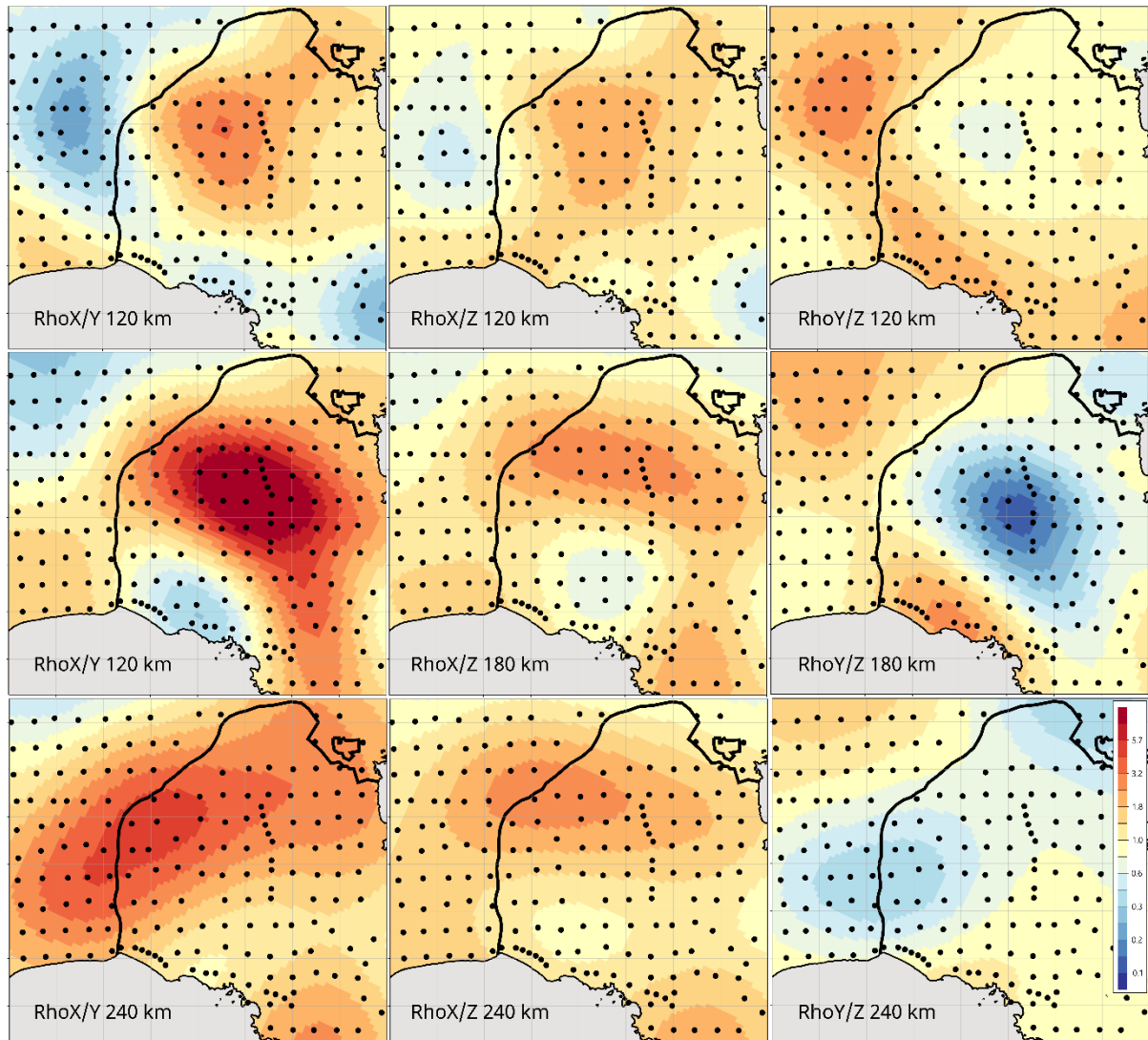
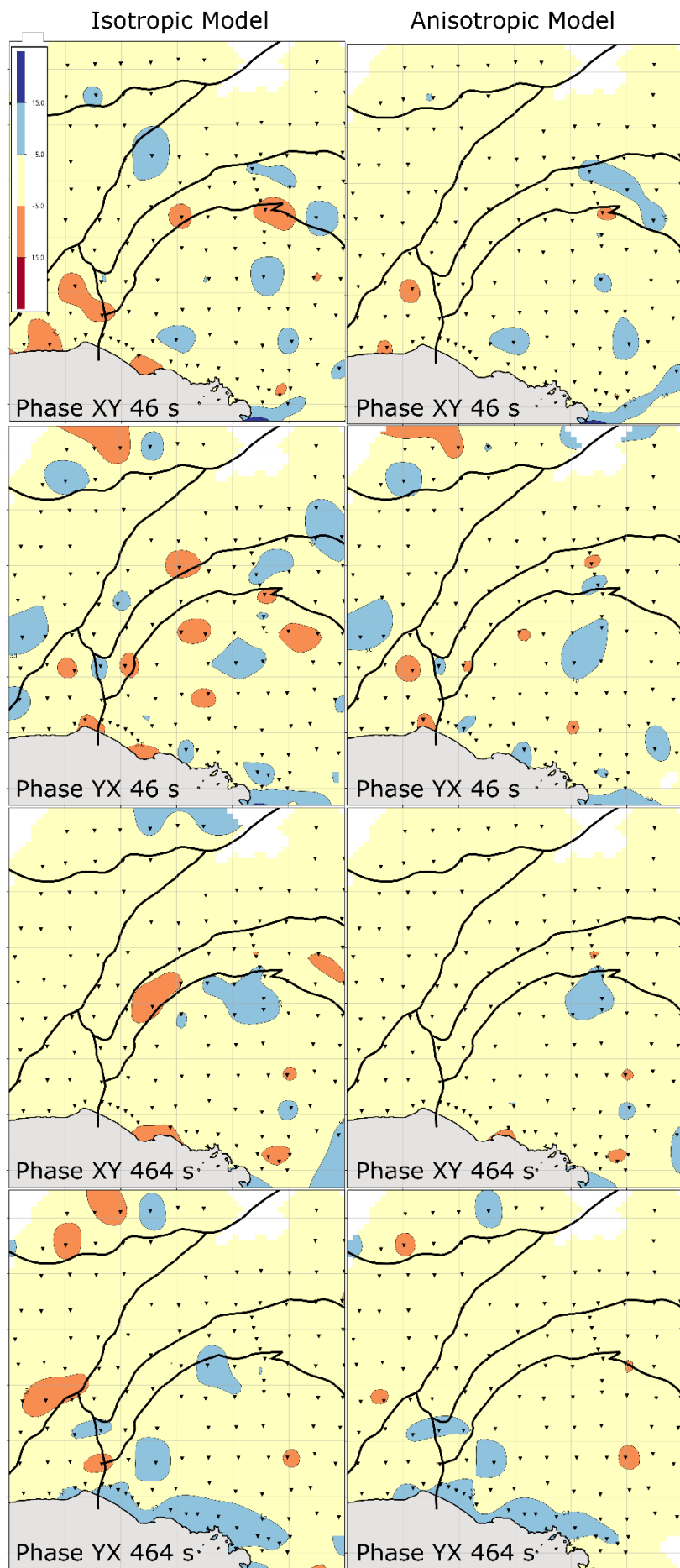


Figure S4. Anisotropy ratios at depths of 120, 180 and 240 km for components of resistivity in orientations of X=25° clockwise from geographic north, Y=115° clockwise, and Z vertical. All figures were produced using Viridien Geotools v.4.0.6.12598 (<https://www.viridiengroup.com/expertise/multiphysics-imaging/geotools>) and Inkscape v1.2.1 (<https://inkscape.org>).

Isotropic and Anisotropic Model-Data Fits

In the main paper, we show that the misfit at the longest period is improved significantly with the anisotropic inversion, which is evidence that the resistivity structure at the base of the lower lithosphere is anisotropic. At shorter periods of 46 and 464 s in Fig. S4 the normalised (observed – model) difference in phase is quite similar for the isotropic and anisotropic models.



71 **Figure S5.** Phase residuals (observed – model) for the XY and YX components of the
72 isotropic and anisotropic models for a period of 46 and 464 s; equivalent figures for period
73 of 4642 s are shown in Fig. 6 in the main paper. All figures were produced using Viridien
74 Geotools v.4.0.6.12598 ([https://www.viridiengroup.com/expertise/multiphysics-](https://www.viridiengroup.com/expertise/multiphysics-imaging/geotools)
75 [imaging/geotools](https://www.viridiengroup.com/expertise/multiphysics-imaging/geotools)) and Inkscape v1.2.1 (<https://inkscape.org>).