THE SCALE AND SCOPE OF CRETACEOUS REFERTILISATION OF THE KAAPVAAL LITHOSPHERIC MANTLE, KAAPVAAL CRATON, SOUTH AFRICA

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I. INTRODUCTION Group II (~150-115 Ma) and Group I (~105-70 Ma) kimberlites occur across southern Africa, often in spatially overlapping domains. These kimberlites carry xenocrystic garnets derived from mantle peridotites. The garnets can be used to define the geotherm at the time of eruption; they also carry geochemical information on processes of depletion and metasomatism.

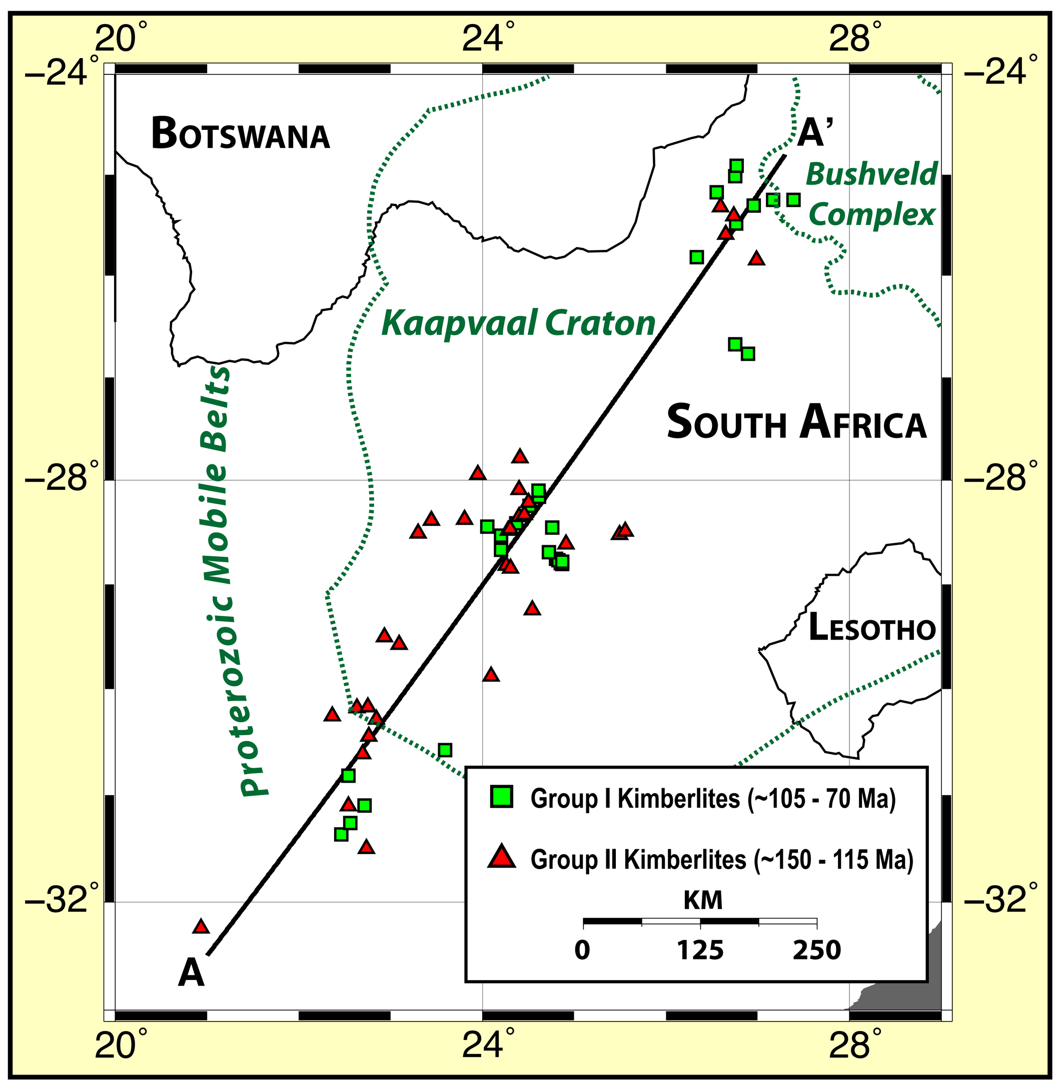
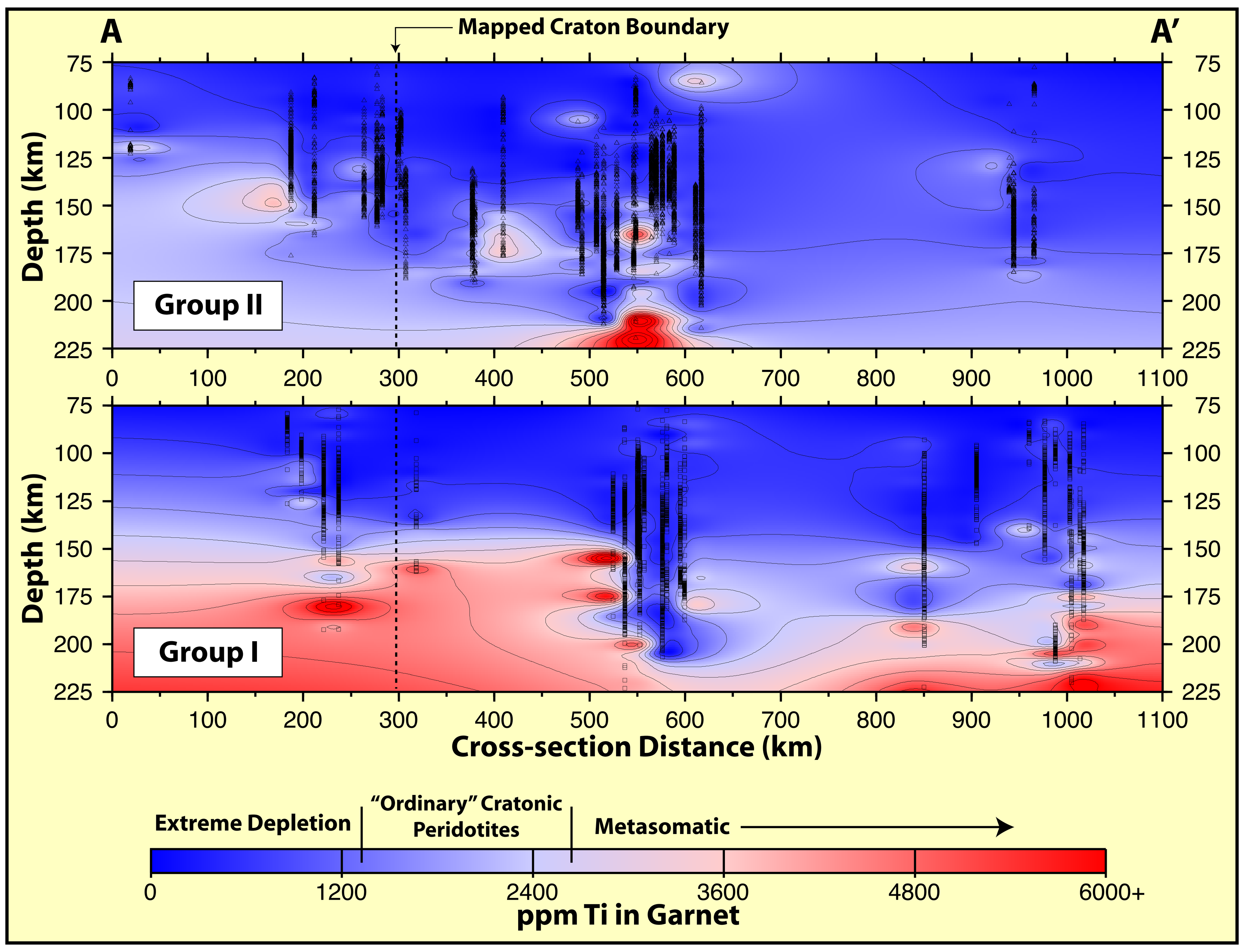


Figure 1. Map of southern Africa, showing the extent of the Kaapvaal Craton and the locations of Group I and Group II kimberlites.

II. GEOTHERMS Major- and trace-element analyses were carried out on 14,480 garnets carried in 34 Group II and 29 Group I kimberlites (**Figure 1**). For the garnets hosted in each kimberlite, we estimate temperature and pressure using the Ni-in-garnet thermometer and Cr solubility barometer, and then construct model geotherms. The shallow portion of these geotherms follow conductive models and the deeper portions, below the point where garnets low in Y become scarce, are kinked parallel to the diamond-graphite stability line. All garnets are then forced onto the geotherm, yeilding depth for each garnet.



III. TRAVERSES Geochemical information from each garnet is projected onto the cross-section (A-A'). For this study we have chosen garnet Ti contents (**Figure 2**), Zr contents (**Figure 3**), the Zr-Y ratio (**Figure 4**) and the calculated X_{Mg} of olivine coexisting with garnet (**Figure 5**). These four parameters are sensitive indicators of mantle melt depletion and different styles of metasomatism. Using a continuous curvature gridding algorithm, the values are contoured along the cross-section.

Figure 2. The contoured Ti content of garnets along cross-section A-A'. The top panel was created using garnets from Group II kimberlites, while the bottom panel was created using garnets from Group I kimberlites.

IV. RESULTS There are clear differences between the mantle sampled by Group II kimberlites and by the slightly younger Group I kimberlites. The very low values of Ti and Zr, and high values of X_{Mg} in the shallow levels of all sections indicates extreme melt depletion. At deeper levels, there is an increase in Ti and Zr, and a decrease in X_{Mg} of olivine, particularly in the younger Group I sections. This probably reflects interaction of infiltrating melts/fluids with the previously depleted lithosphere, especially in the period between the intrusion of Group II and Group I kimberlites. The large increase in the Zr-Y ratio present in the Group I section in **Figure 4** can be correlated with phlogopite-style metasomatism, which affected this area around the same time that melt-related metasomatism was affecting the area off craton to the SW. Low values of X_{Mg} of olivine at the NE end of **Figure 5** may be the related to the intrusion of the Bushveld Complex.

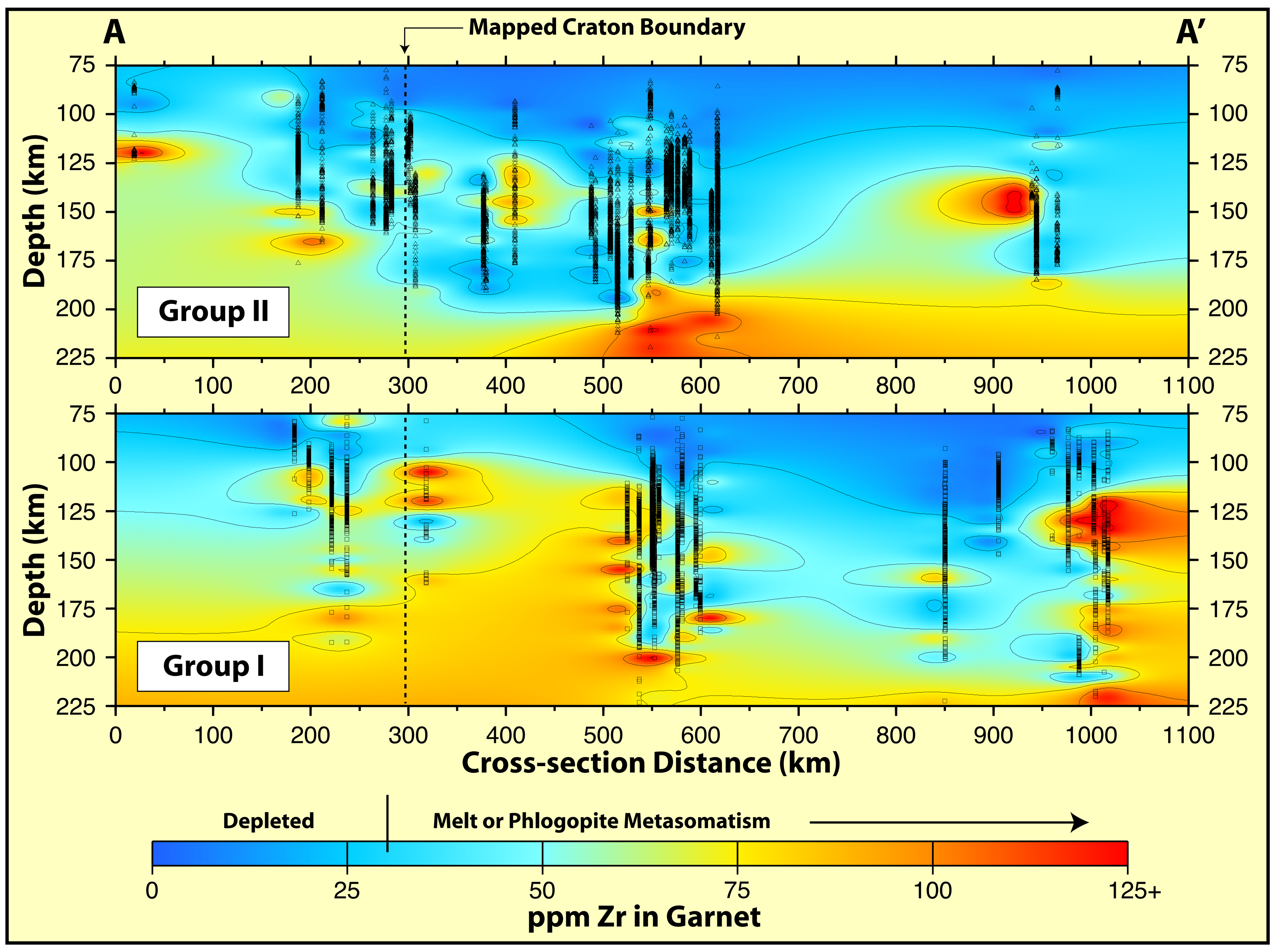


Figure 3. The contoured Zr content of garnets along cross-section A-A', constructed as in Fig. 2.

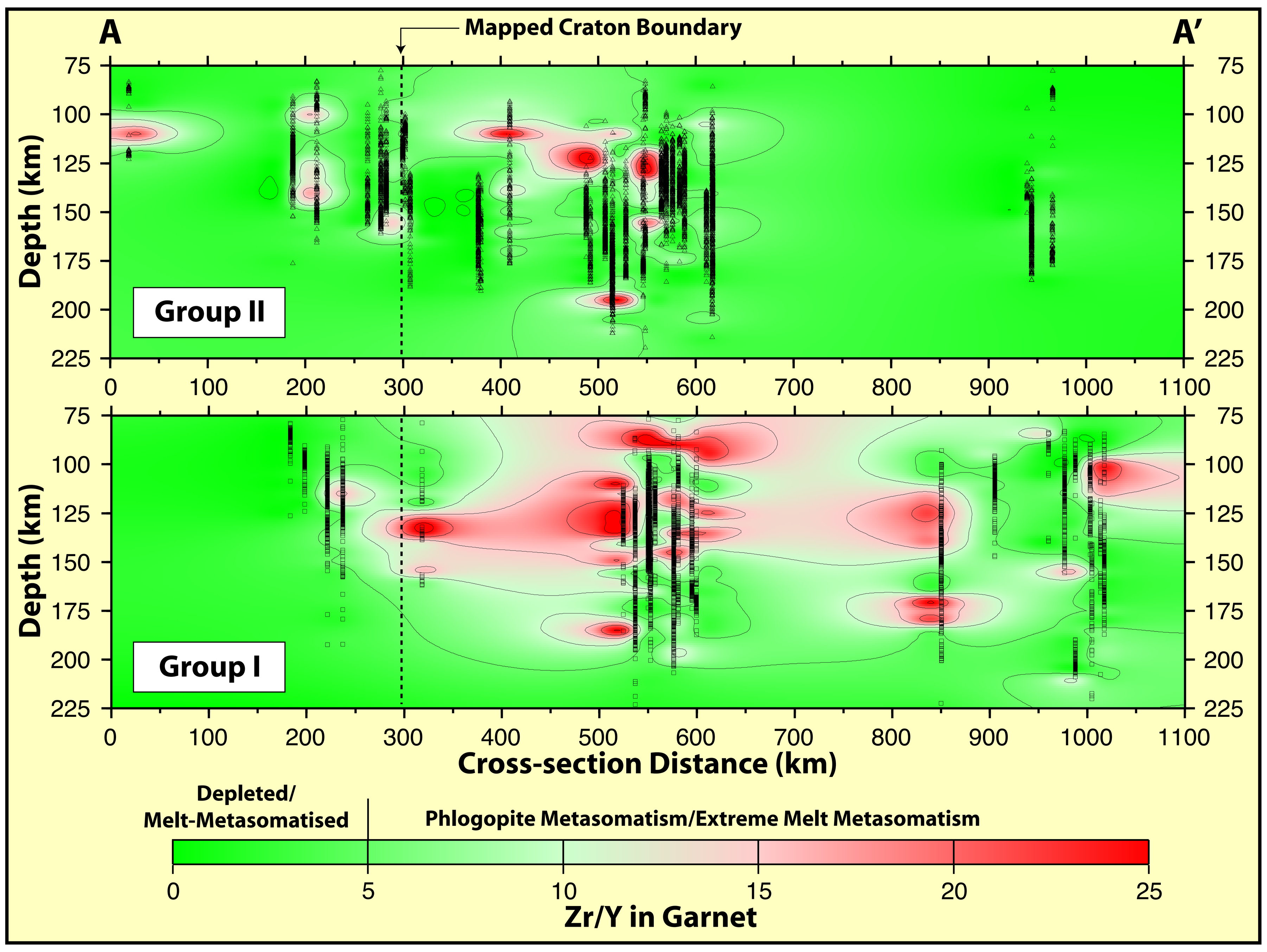


Figure 4. The contoured Zr-Y ratio along cross-section A-A', constructed as in Fig. 2.

V. CONCLUSIONS Peridotitic garnets carried to the surface in Group II and Group I kimberlites record a major metasomatic event in southern Africa.

This event:

> Occurred relatively rapidly 115-105 million years ago between the eruption of the Group II and Group I kimberlites.

> Affects all parts of the craton, but in different ways in different places.

> Demonstrates that cratons, which are usually considered to be chemically and geodynamically stable, are susceptible to rapid and pervasive chemical changes which could serve to destablise and eventually destroy these ancient fragments of lithosphere.

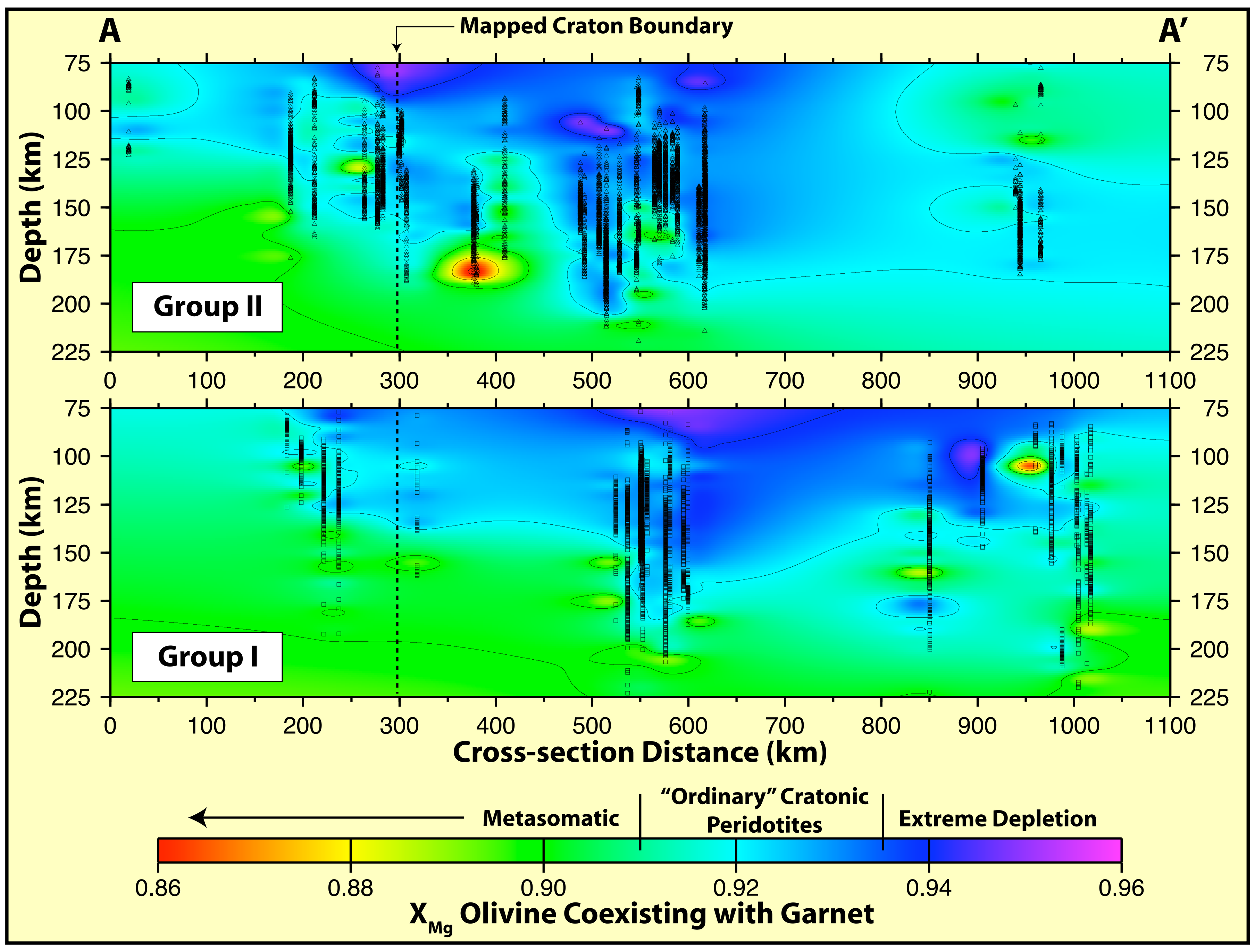


Figure 5. The contoured molar Mg (X_{Mg}) of olivine coexisting with garnet along cross-section A-A', constructed as in Fig. 2.

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