

Supplementary Information

1. Supplementary figures S1 to S7

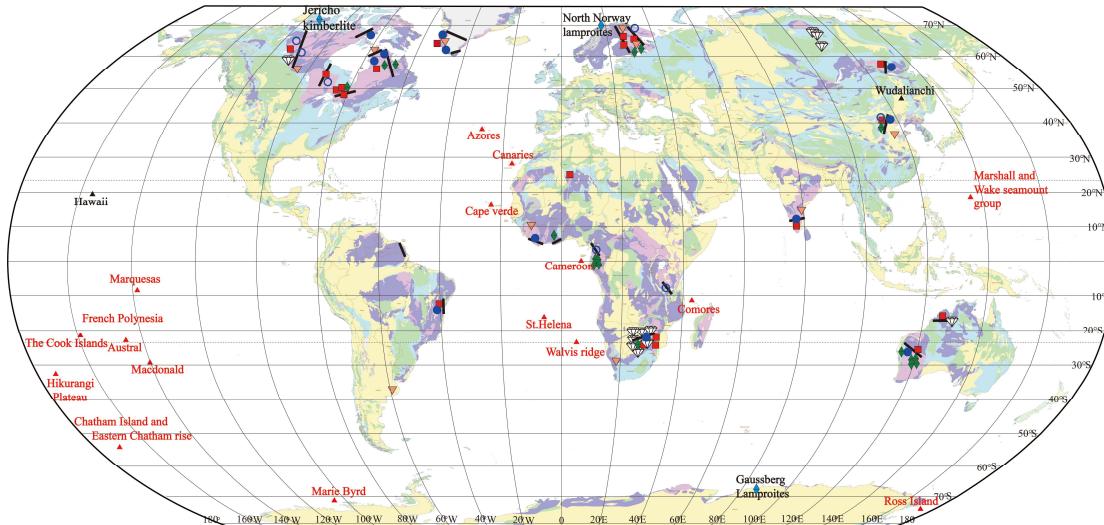


Figure S1: Global Distribution of ocean island basalts, carbonatites, kimberlites, and diamonds This global map showcases the distribution of ocean island basalts, carbonatites, kimberlites, and diamonds included in our study. Adapted from Woolley and Kjarsgaard (2008), it integrates additional information from various sources. The black line outlines the Paleoproterozoic orogenic belt (Zhao et al., 2002). Red triangles indicate HIMU-type basalt (Homrighausen et al., 2018), black triangles represent Cenozoic basalt with a Paleoproterozoic carbonate-bearing source (Huang et al., 2011; Wang et al., 2017; Xu et al., 2020). Diamond icons mark diamond pipes (Howell et al., 2020). Orange inverted triangles denote Paleoproterozoic alkaline basalt, solid blue circles highlight high-pressure Paleoproterozoic granulite (Brown, 2019), hollow blue circles show Paleoproterozoic eclogite locations (Brown, 2019), red squares pinpoint Paleoproterozoic carbonatite sites (Woolley and Kjarsgaard, 2008), green rhombuses represent Paleoproterozoic kimberlite (Tappe et al., 2018), and blue rhombuses indicate Cenozoic kimberlite and lamproite with Paleoproterozoic carbonate-bearing sources (Murphy et al., 2002; Kullerud et al., 2011; Smart et al., 2011).

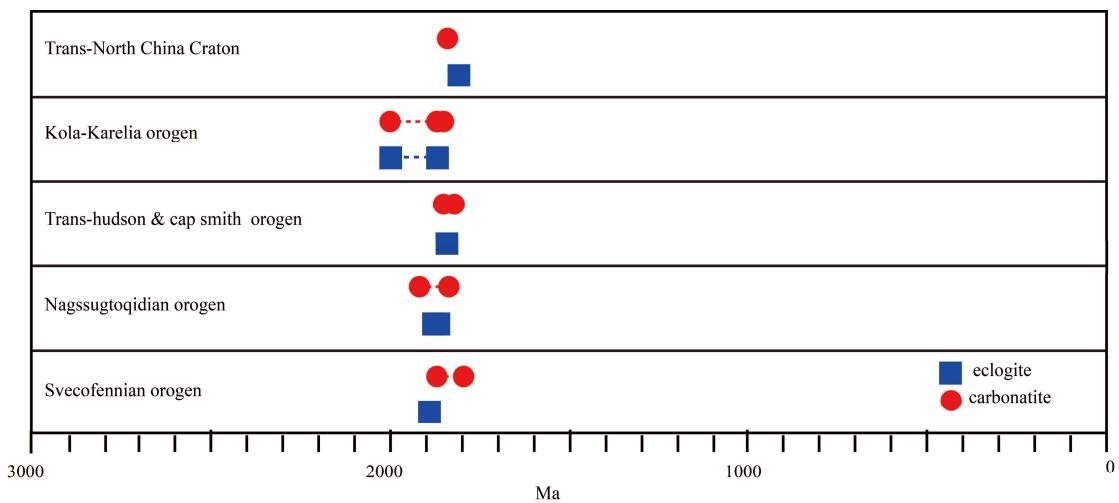


Figure S2: Paleoproterozoic Eclogite and Associated Carbonatite in Orogenic Belts This figure presents the spatial correlation between Paleoproterozoic eclogite (Xu et al., 2018; Li et al., 2023; Weller and St-Onge, 2017; Müller et al., 2018; Smart et al., 2017) and associated carbonatite (see the Supplementary Excel file Sheet ‘basalt’) within the Paleoproterozoic orogenic belts.

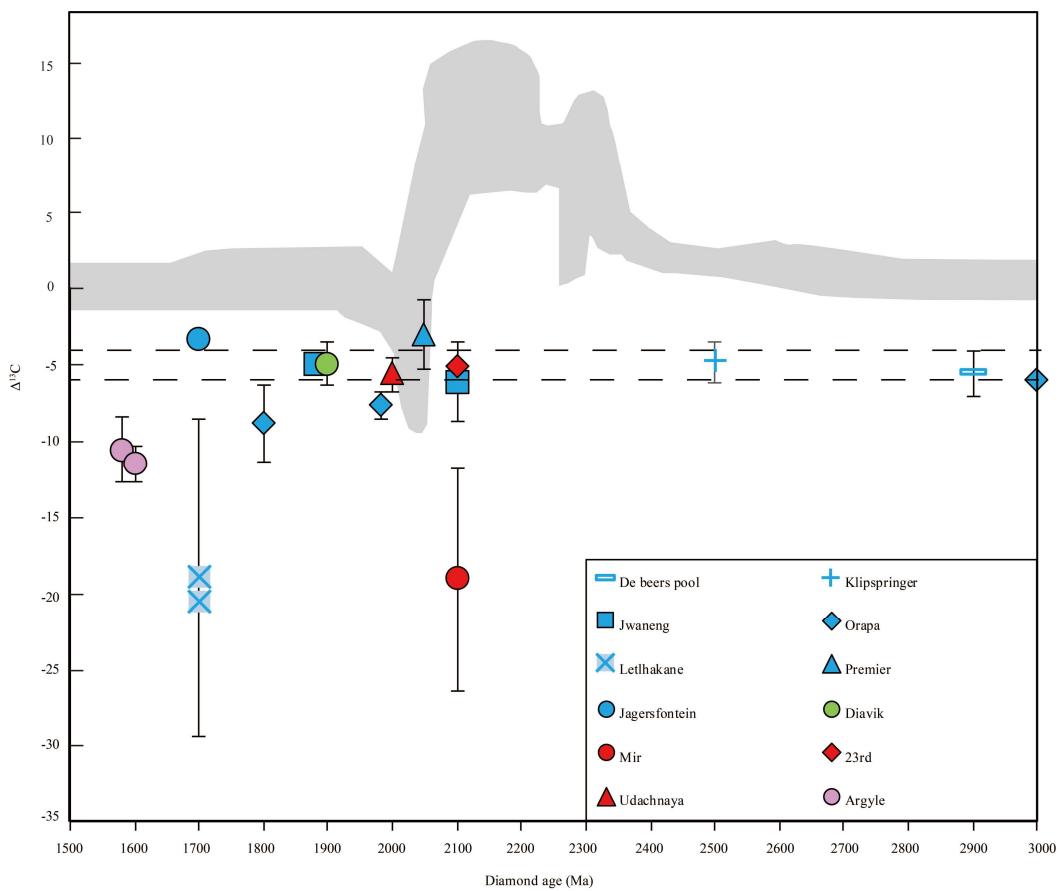


Figure S3: $\delta^{13}\text{C}$ Values of Eclogitic Diamond and Carbonate The diagram illustrates the $\delta^{13}\text{C}$ values of eclogitic diamond (see Supplementary Excel file, Sheet ‘diamond’) and carbonate. The shadowed area represents the $\delta^{13}\text{C}$ values of carbonate (Lyons et al., 2014), while the dashed line delineates the mantle $\delta^{13}\text{C}$ range. Blue coloration denotes the Kaapvaal and neighboring Zimbabwe cratons, red for the Siberia craton, pink for the Kimberley craton, and green for the Slave craton.

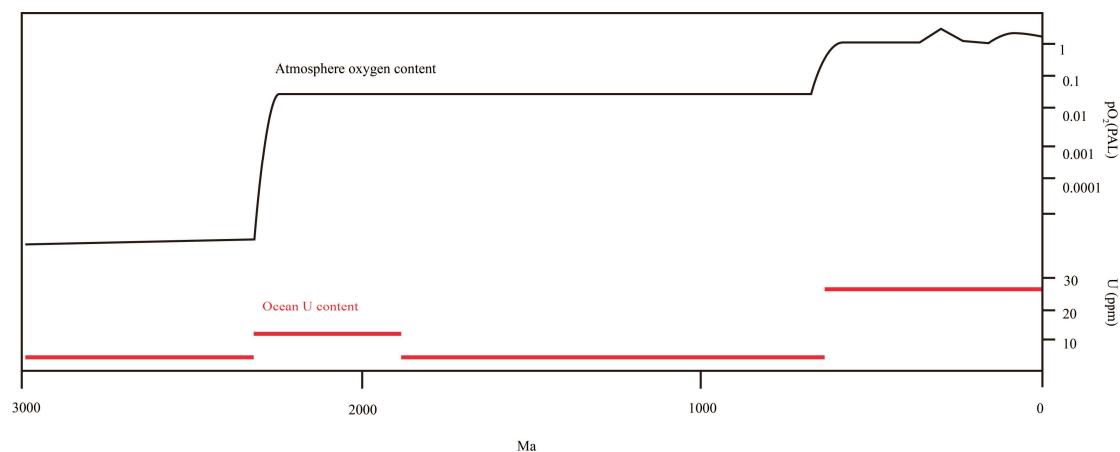


Figure S4: Evolution of Atmospheric Oxygen, and Sediment U Content This figure tracks the evolution of Earth’s atmospheric oxygen content, and sediment U contents in black shale records, illustrating evolving ocean redox conditions over time (Lyons et al., 2014).

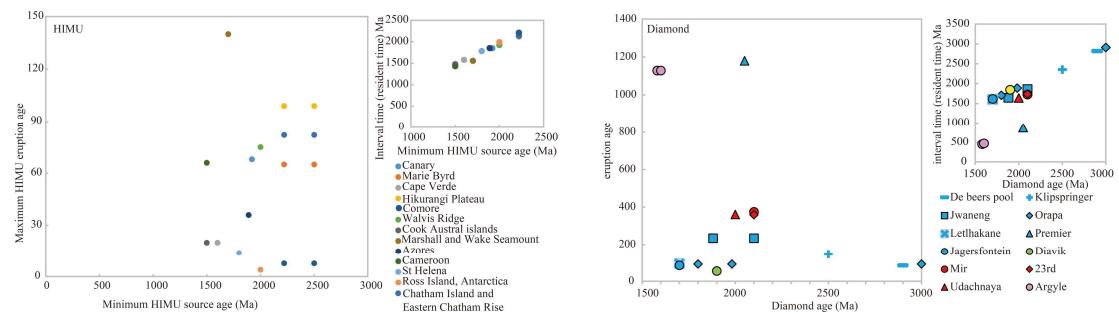


Figure S5: Diamond Age with Kimberlite Eruption Age and HIMU Source Age Range This figure shows the diamond age (see Supplementary Excel file, Sheet ‘diamond’) juxtaposed with the kimberlite eruption age, along with the minimum and maximum HIMU source ages (see Supplementary Excel file, Sheet ‘HIMU’). The carbon residence time of HIMU and diamonds is indicated in the upper right corner. A dashed line represents the minimum age range between 2.22 Ga and 2.5 Ga, marking the disappearance of S-MIF.

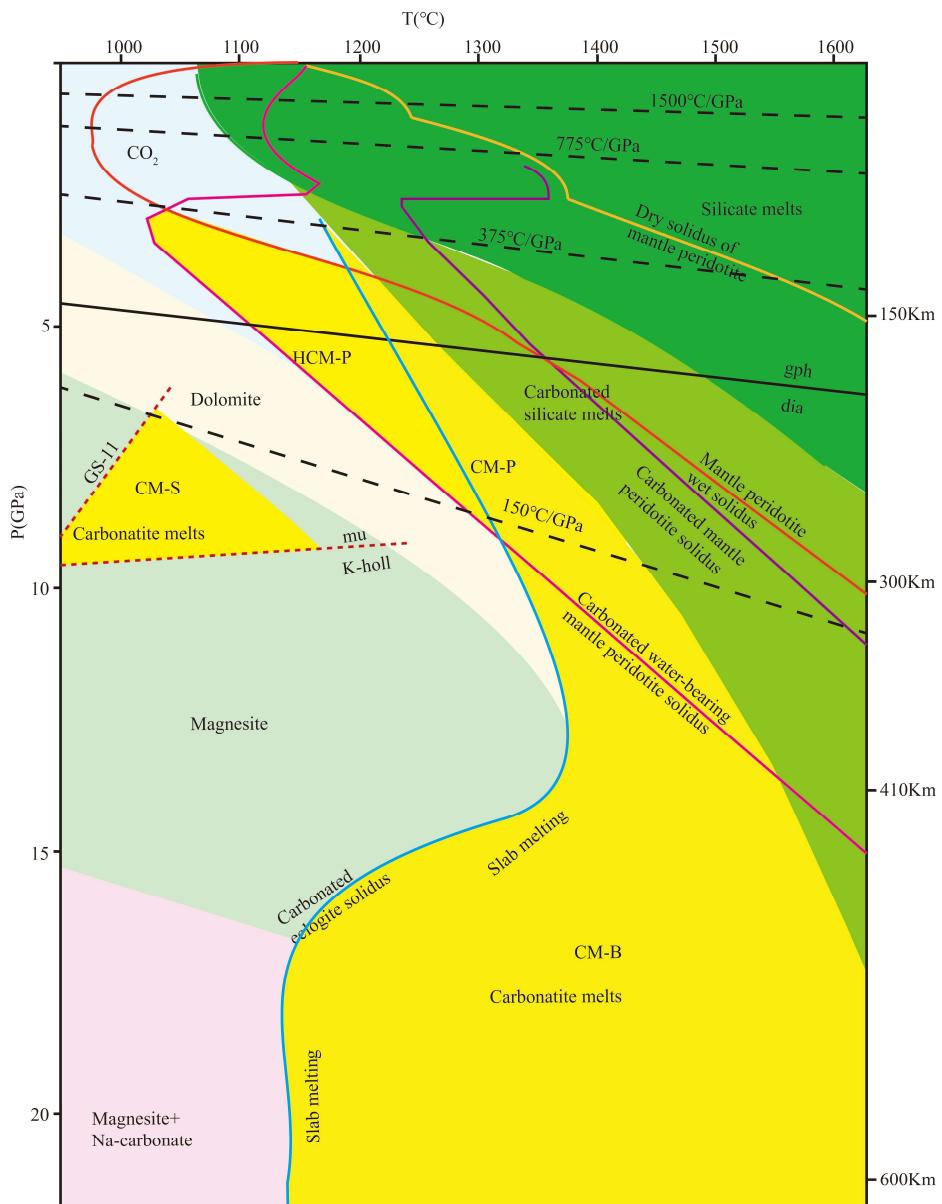


Figure S6: The melting curve of carbonated MORB, carbonated mantle peridotite, and carbonated water-bearing mantle peridotite compared to thermal gradients(Thomson et al., 2016; Brown, 2019; Wei C, 2020). The stability fields of carbon-bearing phases and solidus are identified in different colors. CM-B: carbonatite melts of basalt melting; CM-P: carbonatite melts of peridotite melting HCM-P: hydrous carbonatite melts of peridotite melting; CM-S: carbonatite melts of sediments melting.

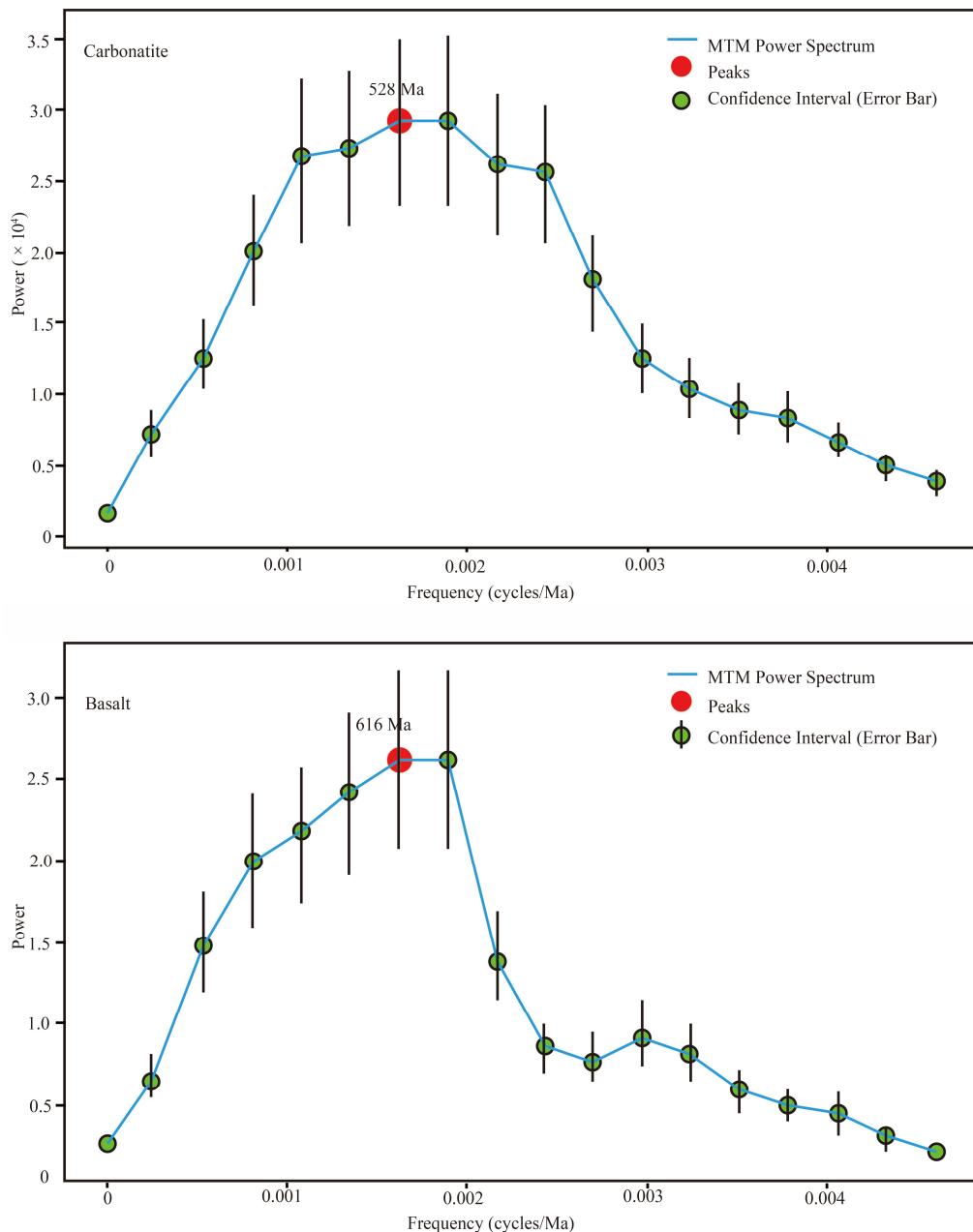


Figure S7: Multi-taper method (MTM) power spectra of carbonatite and basalt curves. The power spectrum calculated using MTM (Multitaper Method) after detrending the average La/Yb values, which were obtained through time-space weighting and Monte Carlo simulation as a function of age in Figure 1. The red points for carbonatite and basalt represent their respective peaks, at 528 Ma and 616 Ma, with power error bars at the 90% confidence interval.

2. Supplementary tables Basalt to E-type diamond