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Iron Isotope Evidence for Limited Direct Oxidation Capability of Recycled Sedimentary Carbonate

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The recycling of sedimentary carbonate is believed to be an effective mechanism for increasing the mantle's oxygen fugacity. However, despite carbonate being the primary mineral in carbonatites, the broad range of oxygen fugacity in carbonatites indicates that the mechanism by which carbonate minerals alter the mantle's oxygen fugacity is complex. Our study shows that deep subduction of sedimentary carbonates may not directly oxidize the mantle. The Neogene Dalihu basalts in Inner Mongolia have higher 87Sr/86Sr ratios (0.7058 to 0.7063), lower δ44/40Ca (0.51 to 0.70‰), and higher δ66Zn (0.35 to 0.45 ‰) than mantle values, suggesting the presence of sedimentary carbonate in their mantle source. However, the partition coefficients of vanadium between olivine phenocrysts and whole rocks indicate normal fO2 for the Dalihu basalts (ΔQFM = -2 to 0.4). Additionally, the basalts exhibit homogeneous δ56Fe values, ranging from +0.08‰ to +0.15‰, falling within the normal mantle range, further indicating that recycled sedimentary carbonate did not oxidize the mantle. Our findings suggest that the assumption that the recycling of sedimentary carbonates will inevitably lead to the oxidation of the mantle is oversimplified. The effect of geological processes, such as decarbonation reactions, should be taken into account.