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Role of subducted sediments in the genesis of alkaline silicate rocks with giant REE deposits: Evidence from lithium isotopes

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Modern renewable energy technologies and low-carbon transportation rely on rare earth elements (REE). Alkaline silicate rocks are significant hosts for REE deposits. The origin of the REE enrichment in the mantle is a crucial issue in understanding the genesis of REE deposits, however, remains unclear. Lithium (Li) isotopes provide a means of testing hypotheses about this issue because they are not affected by high-temperature partial melting and can distinguish between different mantle sources. In this study, we present new Li isotopic data on a large set of alkaline complexes, regional metamorphic rocks, and lamprophyre dikes from the Luxi REE belt in China. The results show that REE-rich alkaline silicate intrusions have lighter Li isotope compositions (δ^7Li = –4.6 to +5.9 ‰) than normal MORB (+2.5 to +4.5 ‰) and OIB (+2.4 to +7.9 ‰). This finding indicates that REE-rich alkaline magmas mainly originate in the lithospheric mantle, and their mantle source has undergone significant metasomatism and enrichment by subducted sediments. During crustal extension, preferential melting of metasomatized domains in the lithospheric mantle leads to the formation of alkaline silicate magmas strongly enriched in the REE. The enrichment of the lithospheric mantle explains the formation of REE deposits at plate margins and is essential for creating world-class alkaline silicate rock-hosted REE deposits.