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Tracing Gangdese Arc Magmatic Tempos with Molybdenum Isotopes

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Subduction not only facilitates the transport of surface materials into the deep mantle, driving crust-mantle material cycling, it is also likely a key factor in continental crust growth and the development of Earth's habitability. During subduction, the formation of arc magmas is not a continuous process but typically exhibits distinct episodic characteristics, alternating between periods of extensive magmatism, known as ‘magmatic flare-ups’, and intervals of reduced magmatic activity, referred to as ‘magmatic lulls’ [1, 2]. This episodic nature is generally referred to as the "tempos" of arc magmatism. However, the underlying causes of arc magmatic tempos remain unclear. Here we conducted detailed molybdenum (Mo) isotope analyses of magmatic rocks from both flare-up and lull periods in the Gangdese arc, southern Tibetan Plateau. Our results show that magmatic rocks formed during flare-ups exhibit relatively heavy Mo isotope compositions, with average $\delta^{98/95}$Mo values comparable to that of the upper continental crust ($\delta^{98/95}$Mo = 0.5‰-0.15‰ [3-5]). In contrast, magmatic rocks formed during lulls have lighter Mo isotope compositions than the depleted mantle ($\delta^{98/95}$Mo = 0.21‰±0.06‰ [6-8]). Notably, these lull-period rocks show significantly higher $(La/Yb)_N$ and $(Tb/Yb)_N$ ratios compared to the flare-up period counterparts. This likely reflects a process in which magmatic flare-ups lead to lithospheric thickening, accompanied by the incorporation of material with light Mo isotopes, which in turn inhibits further magmatism. Therefore, Mo isotope compositions can effectively identify shifts in the source composition of arc magmatism and potential deep geodynamic processes associated with magmatic tempos.

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