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Emergence of modern-style arc magmatism at 2.2 Ga: Evidence from Nb/Ta-Dy/Yb systematics in igneous rocks

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The subduction of oceanic lithosphere is a significant mechanism in plate tectonics, which regulates volcanic activity along convergent plate boundaries on the modern Earth. Although there is evidence for at least episodic hot subduction in the Archaean, modern-style subduction might have not occurred on the early Earth under a different tectonic regime, potentially due to the high mantle temperature. The initiation of modern-style subduction and its associated arc magmatism on a global scale remains uncertain. Here, by compiling over 55,000 intermediate-felsic rocks spanning ages from 3.8 to 0 Ga, we find that the modern arc intermediate-felsic rocks exhibit a distinct Nb/Ta-Dy/Yb correlation compared to their Archaean counterparts. This indicates the widespread occurrence of intermediate-felsic rocks with modern arc signatures since ca. 2.2 Ga, coinciding with the onset of the supercontinent cycle. Continuous subduction of cold oceanic lithosphere not only produced arc magmas along active margins but also accelerated mantle cooling, largely terminating widespread intermediate-felsic magmatism derived from crustal delamination and slab melting that prevailed in the hotter Archaean Earth.