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Age and origin of 12032,366-18

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Sample 12032,366-18, collected from the Apollo 12 regolith, exhibits a unique composition distinct from typical Apollo 12 basalts, suggesting it is not indigenous to the site [1, 2]. It is an olivine-bearing, clinopyroxene-rich basalt with notable enrichment in incompatible trace elements, including 7 ppm thorium—significantly higher than Apollo 12 basalts (<2 ppm) [1, 2]. In-situ Pb isotope analysis using Secondary Ion Mass Spectrometry (SIMS) yields a crystallization age of 3400 ± 16 Ma, confirming it is older than the main Apollo 12 basalts (3.1–3.3 Ga) [3, 4]. Previous ^{40}Ar-^{39}Ar dating suggested a younger apparent age (~2.3 Ga) due to degassing events (~690 Ma) [5]. The high thorium content indicates a significant KREEP component, yet its bulk composition (high FeO and low Al_2O_3) suggests it is unrelated to known KREEP basalts (>3.8 Ga) [2, 3]. Lunar impact events have likely redistributed materials, transporting 12032,366-18 to the Apollo 12 site. A disturbance age of 500–700 Ma suggests an impact event relocated it, distinct from the ~800 Ma Copernicus crater ray where Apollo 12 landed. Instead, Kepler crater (550 km northwest) is a likely source [1, 2, 4, 6]. Thorium-enriched mare basalts (12–15 ppm) near Kepler show chemical similarities with 12032,366-18 [2, 7, 8]. Basalts west and east of Kepler crater, dated between 3.0 and 3.6 Ga, align with the sample's Pb-Pb age [9]. Thus, 12032,366-18 likely originated from a basaltic source near Kepler crater, ejected during its formation, and later transported to the Apollo 12 landing site by impact events.

References:

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