

U-Th-Pb Systematics of Apollo 12 Lunar Samples

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Abstract

Lead isotopic composition and Pb, U, and Th concentrations of Apollo 12 lunar samples are reported and implications of U-Th-Pb systematics for lunar history are discussed. The concentrations (U, 0.16 ~ 0.37; Th, 0.61 ~ 1.28; Pb, 0.28-0.66, in ppm) in Apollo 12 igneous rocks are similar to those of group 2 of Apollo 11 igneous rocks, whereas those in breccia and fines of Apollo 12 are more than ten times higher than those of igneous rocks. The isotopic compositions of lead are extremely radiogenic ($Pb^{206}/Pb^{204} \gtrsim 400$) and observed U^{238}/Pb^{204} values range from 470 to 2700. This indicates that, in lunar material compared to meteorites and terrestrial rocks, the volatile element lead was depleted relative to uranium and thorium. Apparent Pb^{207}/Pb^{206} ages of most Apollo 12 rocks are about 3.9 b.y., whereas concordant ages based on a two-stage evolution indicate 3.2 to 3.8 b.y. The ages are comparable to those of Apollo 11 rocks. It could be postulated that moon's mantle was near melting point about 4 b.y. ago. Apparent Pb^{207}/Pb^{206} ages of fines 12070 and 12033 are 4.5 and 4.3 b.y. and U-Pb ages are discordant. However, analyses of different density fractions of 12070 indicate the existence of a 4.65-b.y. component.