

Rb-Sr AND Sm-Nd STUDY OF ASUKA 881394: EVIDENCE OF “LATE” METAMORPHISM.

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Introduction: The Asuka 881394 achondrite contains fossil ²⁶Al and ⁵³Mn [1,2,3] and has a ²⁰⁷Pb/²⁰⁶Pb age of 4566.5±0.2 Ma [3], the oldest for an achondrite. Preliminary results showed initial ¹⁴⁶Sm/¹⁴⁴Sm = (7.4±1.2) × 10⁻³, indicative of an ancient age, but ⁸⁷Rb-⁸⁷Sr and ¹⁴⁷Sm-¹⁴³Nd ages of 4370±60 and 4490±20 Ma, resp. [1], were younger than expected from the presence of short-lived nuclides. We revisit the Rb-Sr and Sm-Nd chronology of A881394 in an attempt to establish whether “late” metamorphism led to inconsistency in its apparent ages.

Min-Pet: The granulitic texture of A-881394 led [4] to suggest that it had experienced an extensive thermal event in which it lost Na and other volatiles, accounting for its very calcic An₉₈ plagioclase. Prior to discovery of its fossil short-lived nuclides, very calcic plagioclase and unusually magnesian pyroxene were considered to be its most important features [2,4]. It was suggested that Na may have been lost via catastrophic bombardment into a magma ocean during late-stage accretion, resulting in increased anorthite, magnesian pyroxene, and silica at the expense of albite [2].

Rb-Sr data: Combined data from investigations in 2001 [1] and 2010 give a “disturbed isochron” corresponding to 4.50±0.18 Ga. Evidence for early crystallization is preserved in low ⁸⁷Sr/⁸⁶Sr of plagioclase separates. ⁸⁷Rb/⁸⁶Sr is lower than for cumulate eucrites Y980318/433, and comparable to values for angrites. Initial ⁸⁷Sr/⁸⁶Sr = 0.698992±19, within uncertainty of 0.698972±8 for angrite LEW86010 [5], but not clearly resolved from values for eucrites. Handpicked tridymite (2001) and a mineral separate leachate (2010) determine the isochron slope, and when combined with one pyroxene separate and its residue after leaching give an apparent secondary isochron age of 4.0±0.8 Ga.

Sm-Nd data: New data (2010) give an isochron age of 4.524±0.063 Ga, and all thirteen data from both investigations give 4.511±0.033 Ga. It is likely that the Sm-Nd system also has been disturbed. Handpicked tridymite (2001) plus combined leachates (2010) define an apparent age with pyroxenes of 4.4±0.2 Ga. Removing these “outliers” (tridymite and two leachates) leads to a revised age of 4.516±0.037 Ga. Combined data from both investigations give revised initial ¹⁴⁶Sm/¹⁴⁴Sm = (9.1±1.4) × 10⁻³ and T_{LEW} = 4.584±0.023 Ga relative to 4558 Ma [6] and ¹⁴⁶Sm/¹⁴⁴Sm = 7.6 × 10⁻³ for LEW86010 [5].

Conclusion: Disturbed and partially reset ⁸⁷Rb-⁸⁷Sr and ¹⁴⁷Sm-¹⁴³Nd ages appear to be consistent with disturbance of these isotopic systems by some catastrophic or metamorphic events on the A881394 parent asteroid. These events followed an earlier catastrophic bombardment as envisioned by the Na-loss model leading to An₉₈ plagioclase [2]. The occurrence of such events probably continued to times <~4.4 Ga ago.

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