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Assessing the Nature of the Serenitatis Basin Impactor

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The Serenitatis Basin is one of the Moon's largest and oldest impact structures, and its formation timing plays a crucial role in reconstructing the history of lunar bombardment. However, identifying materials directly linked to the Serenitatis impact has been challenging, as much of the basin's ejecta and impact-related lithologies have been altered or obscured by subsequent collisions. Notably, many Apollo 17 impact-melt breccias, once thought to originate from Serenitatis, have since been reinterpreted as having been overprinted by the later Imbrium impact (~3.8–3.9 Ga), complicating efforts to establish a direct connection between collected samples and the Serenitatis-forming event.

Recently, a subset of Apollo 17 Mg-suite norites (78235 and 78236), recovered from a boulder coated in impact melt at Station 8, has been proposed as a promising candidate for preserving evidence of the Serenitatis impact [1]. Previous geochronological investigations of these lunar norites have revealed age clusters around ~4.2 Ga and ~4.3 Ga [summarized in 2], with the former interpreted as the period when pervasive impact-generated melts formed, potentially marking the timing of the Basin's formation [1]. Building on this framework, our study conducts a detailed mineralogical and geochemical investigation of these norites by examining the composition and textures of major silicate phases, impact melt, and associated Fe-Ni metal and sulfides. We aim to refine constraints on the mineral formation pathways, impactor composition and the thermal and petrological processes that shaped these rocks in the aftermath of the impact. These insights will not only enhance our understanding of the Serenitatis impact but also contribute to broader discussions on early lunar impact history, planetary crust formation, and the nature of impactors in the early Solar System.

[1] Cernok et al., 'Lunar Samples Record an Impact 4.2 Billion Years Ago That May Have Formed the Serenitatis Basin'.

[2] Zhang et al., 'Timing of Lunar Mg-Suite Magmatism Constrained by SIMS U-Pb Dating of Apollo Norite 78238'.