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A >500 km-sized Differentiated Planetesimal of Enstatite-chondritic Parentage.

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Two samples of an achondritic lithology of the Almahata Sitta meteorite (MS-MU-019 and MS-MU-036) comprise coexisting orthoenstatite, clinoenstatite and augite. The rock appears to be a residue of the fractionation of basaltic melt from an enstatite-chondritic protolith. Transmission electron microscopy shows evidence that clinoenstatite inverted from earlier protoenstatite. Pigeonite did not form during cooling of the protoenstatite-orthoenstatite assemblage, although augite successfully nucleated. Based on phase relations in the MgO-CaO-SiO_2 system, this suggests that the subsolidus phase evolution took place at P > 0.1 GPa. This implies a minimum diameter of ~500 km of the differentiated parent body, providing a petrological size estimate of the planetesimals that potentially contributed to Earth's accretion. Fast cooling at T < 1260 °C is documented by the cessation of augite equilibration, retention of the 3-pyroxene assemblage and a low abundance of nm-sized orthoenstatite lamella within clinoenstatite. The latter indicates a cooling rate > 1 K/h and indicates a catastrophic break-up of the parent planetesimal while it was still hot.

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