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The Near-Earth Asteroid 25143 Itokawa Observed by Hayabusa: Overviews of Scientific Results at the Rendezvous Phase

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Hayabusa (MUSES-C), an engineering demonstration mission launched by the fifth M-V launch vehicle on 9 May 2003, was designed to acquire samples from the surface of an asteroid and return them to Earth. After cruising with using the ion engines and an Earth swing-by on 19 May 2004, the spacecraft arrived at the “Gate position" about 20 km earthward from an S-(IV) class near-Earth asteroid 25143 Itokawa (1998 SF36) on 12 September 2005. After a period of reconnaissance operation, the spacecraft transferred to the “Home position, ” on 30 September 2005, the nominal hovering site at about 7 km earthward from the asteroid. In November, some trial descents for sample collection were condcted, including two surface landings. During a three-month’s close proximity phase, Hayabusa provided scientific information by remote observation of Itokawa. A surface map to sub-meter resolution has been generated and mineralogical and elemental compositional data taken. It indicates LL- or L-chondrites are most likely and no regional mineralogical and elemental variation is found although some local heterogeneity in color and albedo is observed. The size of the asteroid is measured 535 x 294 x 209 meters and the bulk density is 1.9 g/cc (7% uncertainty), indicating high porosity and possibly a rubble pile origin. The overall structure looks relatively rounded, not angular as expected, and has dichotomy with rough and smooth areas. One of a few smooth areas, Muses Sea, corresponds to a gravity low and the paucity of obvious impact craters suggests an effective resurfacing process. While there is evidence for a regolith, there are also numerous bare rock boulders and pillars that may suggest an early collisional breakup followed by a re-agglomeration into a very rough object.