INTRODUCTION: Particles of S-type asteroid 25143 Itokawa were successfully recovered by the Hayabusa mission, and at least 1500 recovered particles have been identified as having an Itokawa origin [1, 2]. This is the first sample recovered from an asteroid and returned to Earth, and the second extraterrestrial regolith to have been sampled, the first being the Moon, which was sampled by the Apollo and Luna missions. We obtained three-dimensional (3-D) structures of Itokawa particles using X-ray microtomography in the Hayabusa sample preliminary examination in order to understand their textures in comparison with meteorites and the 3-D shape features in connection with the regolith formation and evolution on the asteroid [2].

EXPERIMENTS: Forty particles of approximately 30–180 μm in size were imaged at BL47XU of SPring-8 with effective spatial resolutions of approximately 200 or 500 nm. Imaging at two X-ray energies of 7 and 8 keV made identification of minerals in CT images possible. A successive set of 3-D CT images, which shows quantitative 3-D mineral distribution, was obtained for each particle.

RESULTS AND DISCUSSION: Modal mineral abundances of the whole sample and the bulk density (3.4 g cm⁻³) calculated from the modal abundance and average chemical compositions of the minerals [1] are similar to those of LL chondrites. 3-D structures of the particles having textural variations indicate a mixture of equilibrated and less-equilibrated similar to those of LL chondrites. 3-D structures of the particles having abundance and average chemical compositions of the minerals [1] are successfully recovered by the Hayabusa mission, and at least 1500 recovered particles have been identified as having an Itokawa origin [1, 2]. This is the first sample recovered from an asteroid and returned to Earth, and the second extraterrestrial regolith to have been sampled, the first being the Moon, which was sampled by the Apollo and Luna missions. We obtained three-dimensional (3-D) structures of Itokawa particles using X-ray microtomography in the Hayabusa sample preliminary examination in order to understand their textures in comparison with meteorites and the 3-D shape features in connection with the regolith formation and evolution on the asteroid [2].

METHOD: We have irradiated two batches of Allende sodalite (Pink Angel) with different fluencies of fast neutrons in the Cd-shielded CLICIT facility of the Oregon State TRIGA reactor. In the absence of trapped argon, the upper intercept of a plot of 36Ar/38Ar against 37Ar/38Ar defines a relationship between 36Ar and 38Ar from the action of cosmic ray-induced secondary neutrons and mono-isotopic 36Ar from 36Cl decay. By combining data from two irradiations, the two contributions can be unambiguously distinguished. Figure 1 shows allowed combinations of 36Cl/35Cl and the product of cosmogenic secondary neutron fluence and 36Cl cross section for each series. The intersection corresponds to 36Cl/35Cl = (1.9 ± 0.5) x 10⁻² and <e>Φ> = (1.1 ± 0.8) x 10⁻¹⁰.

The latter is in accord with the neutron fluence observed in CAIs in Allende [4]. The 36Cl/35Cl ratio is 3 orders of magnitude lower than the maximum value inferred from 36S excesses. If interpreted chronologically, i.e., as a closure age, it would correspond to a period of 3Ma or so of activity involving the precipitation of sodalite, which is consistent with I-Xe data [5]. Alternatively, the low ratio may represent 36Ar loss in line with the low activation energy for Ar diffusion in sodalite. The presence of excess 36Ar together with 36S supports the idea that live 36Cl was present in the sodalite, as opposed to the 36S being inherited. The mechanism for producing 36Cl several million years after the formation of the solar system is still unknown.