**Introduction:** Fujiwara et al. described Itokawa as a “rubble pile” [1] and it is easy to understand why (Fig. 1). The surface of this tiny 0.535 x 0.294 x 0.209 km near-Earth asteroid is covered with unconsolidated cm-sized and larger gravel and boulders [2]. Its shape suggests that it is bifurcated. The lunar surface is very similar and consists of a thick regolith of fine grained material strewn with boulders of a wide size range (Fig. 2). Thus, I argue that Itokawa is not a rubble pile, but a regolith breccia.

**Properties of Itokawa:** Probably the most quoted observational evidence for rubble piles is the relationship between the rotation rate of asteroids and their size (Fig. 2) [5]. It is often argued that the limit for rotation rates of 2.2 hour for asteroids >200 m suggested that these were rubble piles, whereas the faster rotation rates for asteroids <200 m suggests that they are monoliths. With a period of 12 h, Itokawa is the plots near the transition between the purported rubble piles and monoliths, slightly to the rubble pile side. However, recent calculations challenge these conclusions and suggest that <200 m objects have sufficient cohesion for them also to be composed of fine particles rather than monoliths [6].

Itokawa has a density of 1.9 g/cm$^3$, a reflectance spectra of an S asteroid, and the mineralogy of the returned grains is that of an LL chondrite. The low densities of asteroids (~2.0 g/cm$^3$ for C asteroids, ~2.5 g/cm$^3$ for S asteroids) are ~1 g/cm$^3$ lower than the grain densities of the minerals inferred from spectra. The low density is normally ascribed to porosity. On this basis, Itokawa has one of the highest porosities known, ~45%, much higher than other S asteroids. The often reproduced diagram of mass against postulated porosity appears in Fig. 4a [7]. This is interpreted to reflect internal strength: C indicates “coherent”, F = “fractured”, T = “transitional”, and LC = “loosely coherent”. However, it should be noted that the water content, inferred from the usual meteorite associations, also increases left-to-right in the diagram (from traces to ~20 vol %). Shown in Fig. 4b are mass balance calculations which indicate that internal water can also explain the low density of asteroids. There is now considerable evidence for subsurface water in asteroids inside the “snow line” [8].
regolith in one form or another can be found in nearly every one of the 30,000 high-resolution images of Eros [15]. A deficiency of craters <200 m on Eros [14] and <0.6 km on Steins [12] and Lutetia (locally) [13] suggest that their regoliths often may be this deep. Itokawa could well be a piece of the regolith of a, say, 50 km asteroid.

**Implications for science, exploration, planetary defense, and resources:** *Science.* The internal nature of asteroids is a question of considerable importance in understanding the origin and history of the asteroid belt [e.g. 8].

**Exploration.** The internal texture of asteroids, especially small asteroids, will affect the way in which spacecraft and humans can function on an asteroid. A coherent monolith, a rubble pile and a regolith breccia may well have different requirements for tethering, for example.

**Planetary Defense.** An important element of understanding the behavior of objects entering the atmosphere is knowing their internal texture. Atmospheric behavior is dominated by fragmentation processes and these will differ markedly between monoliths, rubble piles and regoliths.

**Resources.** As with “exploration” above, the mechanics of surface operations will depend on internal texture. The presence of water is also important because this is probably the most important resource to be obtained from asteroids.

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