**Introduction:** Since asteroids are thought to be survivors of planetesimals or fragments of planetesimals[1], they maintain primordial information about history of the solar system[2]. Therefore, observation of current asteroids and analysis of meteorites and returned samples originating from asteroids provide us with important keys to understanding the origin and evolution of the solar system.

On all solid bodies including asteroids in the solar system, collisions are ubiquitous events. Collisions between two planetary bodies at speeds of several km/s cause significant heating of materials[3], resulting in a loss of Ar, dehydration, and/or the generation of impact melts. Since the degree of impact heating depends strongly on the impact velocity, detailed geochemical analyses of such heated samples allow us to characterize the impact environment in the solar system through its history.

**Effect of Material Strength:** Recently, we reported that the degree of heating during impacts with less than 10 km/s is expected to be much higher than previously expected[4]. We used the two-dimensional model of the iSALE shock physics code[5]. The strength model for rocks and ANEOS for dunite were applied for both projectile and target. We found that the post-shock temperature in strength-supported media could be much higher than that in the case without strength, i.e., purely hydrodynamic (Fig. 1). Plastic deformation of the pressure-strengthened comminuted rocks dissipates the energy, and converts the kinetic energy of the flow field to internal energy. Thus, the required impact velocities for producing the unique features produced mainly by the rise in temperature is greatly lowered.

This additional heating can also be observed in an oblique impact (Fig. 2) by using the three dimensional version of the iSALE code[6]. It was expected that the heated mass in an oblique impact would be lower than that in a vertical impact, because the vertical component of the impact velocity is generally thought to govern pressures and temperatures experienced during the impact. However, our models show that vertical and oblique impacts can generate nearly the same amount of heated mass in total, indicating that the additional shear heating is more effective in oblique impacts.

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**Figure 1:** Snapshots of a head-on impact between a spherical impactor and a flat target at 3 km/s in the case without strength (left panel) and with strength (right panel). Color represents the temperature.

**Figure 2:** Cumulative target mass of peak temperature normalized by the impactor mass. Black and green lines are the impact of 45° and 90°, respectively. Solid and dotted lines are without and with material strength, respectively.
Deyhydration During Collisions: Focusing on dehydrration of hydrous minerals, we numerically performed head-on planetesimal collisions. The target planetesimals are assumed to be 100 km in radius with 90 km sized core of hydrous materials and 10 km anhydrous layer. In our numerical calculations[7], we vary the size of impactor that does not contain hydrous materials and impact velocity. Here, we focus on occurrence of dehydrration reaction in hydrous core triggered by planetesimal collisions. We assume the dehydrration reaction occurs at 600ºC based on experimental works.

The mass fraction of surviving hydrous materials in ejected materials and remaining largest body are plotted in Figure 3. In most cases, nearly half of the ejecta seems to be hydrous material. On the contrary, the ratio of hydrous materials forms a major component in the remnant. We can conclude that hydrous materials can avoid the dehydrration reaction and also be ejected from the system of planetesimal collisions for a typical impact velocity (~ 5 km/s) in the current asteroid belt.

Considering this realistic additional heating, we will discuss the fates of hydrous materials in parent bodies of carbonaceous chondrites like Ryugu and Bennu during disruptive collisions.

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Figure 3: The mass fraction of hydrous materials in ejecta (left) and remnant (right) for various impact velocities ranging from 2.5 km/s to 10 km/s and impactor radius from 10 km to 40 km after the collisions with 100-km sized target planetesimal.