The Jovian Early Bombardment. The formation of Jupiter, plausibly the first giant planet to appear in the Solar Nebula, triggered the first bombardment (i.e. a sudden spike in the flux of impactors) in the history of the Solar System (Safronov 1972; Weidenschilling 1975; Weidenschilling et al. 2001; Turini et al. 2011, 2012). This Jovian Early Bombardment (Turini et al. 2011, 2012), was caused by two populations of impactors:

1. **Icy planetesimals** in the outer Solar System scattered by Jupiter or affected by the orbital resonances it created (Safronov 1972; Weidenschilling 1975; Weidenschilling et al. 2001, 2012).
2. **Rocky planetesimals** ejected from the asteroid belt due to the effects of the Jovian orbital resonances (Turini et al. 2011, 2012).

The second population is the dominant one in the inner Solar System, being of orders of magnitude larger than the first one (Fig. 3).

Intensity and duration of the Jovian Early Bombardment. The Jovian Early Bombardment is relatively short, lasting about 1 Ma (Weidenschilling 1975; Turini et al. 2011, 2012) with the bulk of the impacts concentrated in the first 0.3-0.7 Myr (Turini et al. 2011, 2012).

During the Jovian Early Bombardment, the number of cometary impactors crossing the asteroid belt can significantly increase but the range of impact velocities (4-12 km/s) does not change (see Fig. 4). In the case of asteroidal impactors, both the numbers of projectiles and their impact velocities decrease (see Fig. 5). Planetary migration (e.g. due to cratering is less than 1 km/s, a growing fraction of asteroidal impactors achieves impact speed between 2-10 km/s (see Fig. 6) and causes net mass loss.

Even if it is extremely short, the Jovian Early Bombardment is very intense due to the large, pre-depletion population of planetesimals in the asteroid belt (Weidenschilling 1975; see also Coradini et al. 2011 for a discussion of the Jovian Early Bombardment and the depletion process of the asteroid belt). In the most likely case (see Fig. 5, size-frequency distribution from Weidenschilling 2011) the bulk of the impactors is constituted by km-sized planetesimals (Turini, submitted).

Jovian Early Bombardment and planetary migration. The formation of Jupiter is the sole necessary condition to trigger the Jovian Early Bombardment; yet migration can play an important role in enhancing its effects due to the sweeping of the resonances through the inner Solar System (Weidenschilling 2011). While a large number of impact events with asteroidal projectiles can result in net mass loss (see Fig. 4), impact speeds lower than 1 km/s, a growing fraction of asteroidal impactors achieves impact speed between 2-10 km/s (see Fig. 6) and causes net mass loss.

Jovian Early Bombardment and catastrophic impacts. Due to the short duration of the Jovian Early Bombardment, the probability of planetesimals undergoing a catastrophic impact are quite limited.

As shown in Fig. 7, the early planetesimals that had a high chance of being disrupted during the Jovian Early Bombardment are 100 km large, having in agreement with the current understanding of the collisional evolution of asteroids (see e.g. O’Brien & Sykes 2011).

Jovian Early Bombardment and cratering erosion. During the Jovian Early Bombardment, the collisional evolution of planetesimals is dominated by the process of cratering erosion (e.g. Coradini et al. 2011; Turini et al. 2011). The cumulative mass loss due to cratering is large enough to destroy planetesimals with diameter of 200 km and can affect also planetesimals as big as 800 km (see Figs. 7 and Turini et al. 2011).

As shown in Fig. 8, planetary migration and the sweeping of the resonances causes an increase significantly the efficiency of cratering erosion in destroying the planetesimals during the Jovian Early Bombardment (Coradini et al. 2011).

Figure 3: Comparison of the fluxes of cometary and asteroidal impactors during the Jovian Early Bombardment using Vesta as a case study. The red area marks the last 1 Myr of the event, with the temporal interval over which Jupiter is accreting. The blue line marks the Jovian Early Bombardment. The size-frequency distribution of the impactors has been divided by a factor 100 (see Figs. 4). Figure adapted from Turini et al. (2011).

Figure 4: Evolution of the impact velocities in the asteroid belt during the Jovian Early Bombardment using Vesta as a case study. The red area marks the last 1 Myr of the event, with the temporal interval over which Jupiter is accreting. The blue line marks the Jovian Early Bombardment. The size-frequency distributions refer to Figure 5, the asteroid belt (Weidenschilling 1975; Turrini et al. submitted). In the most likely case (see Figs. 5, size-frequency distribution from Weidenschilling 2011) the bulk of the impactors is constituted by km-sized planetesimals (Turini et al. submitted).

Figure 5: Size-frequency distributions of impactors during the Jovian Early Bombardment used in Vesta impact studies as case study. The size-frequency distributions refer to the impactor population model of Coradini et al. (2013) (label "C"), matched to the data reported in Turrini et al. (2012) (label "T"), in the asteroid belt. Due to the short duration of the Jovian Early Bombardment, the probability of planetesimals undergoing a catastrophic impact are quite limited.

Figure 6: Timeline of the Solar System from the condensation of the first solids, the Ca-Al-rich inclusions (CAIs), to present. Figure adapted from Scott 2007.

Figure 7: JEB: Catastrophic Destruction. Figure adapted from Turini et al. (2012) for the size-frequency distribution by Coradini et al. (2011).

Figure 8: JEB: Mass Erosion. Figure adapted from Turini et al. (2012) for the size-frequency distribution by Coradini et al. (2011).

Bibliography:
- O’Brien, D. P., Sykes, M. V. 2011, Space Science Reviews 163, 41;see Figs. 6 and 7 and Turrini et al. 2011, 2012)
- Coradini, A., Turrini, D., Marzari, F. 2011, Space Science Reviews, 163, 25; see Figs. 6 and 7 and Turrini et al. 2011, 2012)
- Weidenschilling, S. J. 2011, Icarus, 214, 671; see Figs. 6 and 7 and Turrini et al. 2011, 2012)