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A1 2 Armageddon Outta Here!

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Abstract

Armageddon is upon us. The brave team of oil rig workers have failed to blow up the Texas-sized asteroid, and it is hurtling straight towards us! Based on Armageddon (1998), this paper will investigate what would happen to humanity if the 'global killer' asteroid had actually hit the Earth, and calculates that the diameter of the crater formed, at 7346 km, would be larger than the radius of the planet. It is determined that the effects of this justifies the asteroid's title of 'global killer'.

Introduction

In 1998 the hit movie Armageddon [1] crashed onto movie screens and told the story of an end of the world scenario; an asteroid the size of Texas had been ejected from the Main Asteroid Belt after a collision with a rogue comet and sent hurtling into the inner Solar System. Initially missed by NASA, they learned that they had only eighteen days to divert the catastrophe and save the planet. Luckily Bruce Willis and his team of oil rig workers came to the rescue and were sent out to blow up the asteroid using a drill and a nuclear bomb. In the movie they succeeded in saving the planet, but this paper investigates what damage would be caused if they had failed; specifically the size of the crater that would be formed upon impact and whether or not the asteroid was indeed a 'global killer'.

Calculations

Some initial assumptions are required in order to determine the scale of potential damage which could be caused; it is assumed (as stated in the film [1]) that the asteroid has a diameter equal to the length of Texas at its longest point (a value of 1250 km [2]), and that it can be approximated to a spherical body. Next, we assume that the asteroid is 'S-complex', a type of asteroid with a stony composition [3]. Upon analysing the film it can be noted that the asteroid is made predominantly of stony material with traces of a metallic composition, therefore making the S-complex hypothesis most likely. The final assumption made is that the angle of impact is 45°, which is the average found for planetary impacts and is in fact determined through mathematical derivations in prior literature to be most likely [4]. In order to calculate the actual size of the impact crater which this rogue projectile would form, the Melosh Scaling Law [5] is required. This equation relates a series of parameters to the initial (transient) crater diameter (D_{tc}), given in kilometres. For the sake of this paper, only the transient crater diameter will be calculated, and not the final crater, which would be formed after a series of intermediate modifications and may potentially be larger than the transient crater.

$$D_{tc} = 1.161 \left(\frac{\rho_p}{\rho_t}\right)^{\frac{1}{3}} L^{0.78} v_i^{0.44} g^{-0.22} sin^{\frac{1}{3}}(\theta) \quad (1)$$

Here, ρ_p is the density of the projectile (in our case the asteroid), and for an S-Complex the density is approximately $\rho_p = 2.71$ g/cm^3 [6]. The parameter ρ_t is the density of the target body, which in this case is the Earth (at ~ 5.51 g/cm^3 [7]). L is the diameter of the asteroid in km, and v_i is the impact velocity. In the movie it is stated that the asteroid was hurtling towards the Earth at $22,000$ mph (≈ 9.83 km/s). The final two parameters are g, which is the acceleration due to gravity of the target body (for Earth it is 9.81 m/s^2) - assuming that atmospheric drag is negligible due to the size of the asteroid - and θ, which is the angle of impact, where that (as stated previously) is 45°. This equation yields a value of 7346 km for the diameter of the transient crater caused by the Armageddon asteroid.

Discussion

The transient crater diameter calculated is evidently very large, which, realistically is to be expected of an asteroid that has a diameter of 1250 km. To put things into perspective, at 7346 km, the crater is almost 15% larger than the radius of the Earth - which stands at 6378 km. The famous Chicxulub crater, which caused the K-T extinction event that ended the reign of the dinosaurs, was formed by what is estimated to be a 10 km asteroid and sits at a diameter of 200 km [8]. It is fair to assume that life as we know it would not survive such a cataclysmic event, and our planet would never be the same again. As stated in the movie, the asteroid is a 'global killer', which is an accurate way of describing such an object and probably one of the only accurate scientific statements in the movie. In reality, however, an object of that size would have been detected years - potentially decades - before an impact event could occur and more realistic ways of removing the threat would have been implemented; such as the methods recently tested in NASA's DART mission, where it was proven that an asteroid can be redirected onto a new trajectory [9]; but that is an outcome for another paper.

Conclusion

The asteroid from the 1998 movie Armageddon would cause a cataclysmic event so large that it is likely that nothing would survive. With a crater diameter of 7346 km, it would decimate the surface of the Earth. If this fictional scenario was in fact real, we can conclude the Earth's population would indeed be doomed.

References

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