Imperial College London

Institute of Shock Physics: Computational Modelling

Shock Waves in Earth and Planetary Sciences

- Impacts shaped the solar system and the evolution of life:
  - Collisional accretion of the planets
  - Formation of the moon in a giant impact
  - Transfer of material between planets via impact ejecta
  - Impact induced hydrothermal systems may have provided a cradle for early life
  - Environmental catastrophes following impacts leading to mass extinctions

- Improved models of material response to shock waves is vital for advancing understanding of impacts and their implications

- Shock modelling technology can be applied to a wide variety of Earth processes, e.g. landslides, tsunamis, eruptive volcanic flows
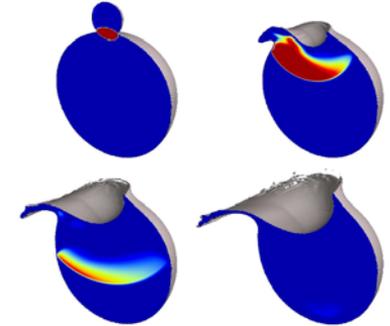

Models of Asteroid Collisions and Impacts on Earth

- Planetary-scale impact research:
  - Asteroid survivability
  - Consequences of large impacts
  - Shock heating in planetesimal collisions
 - Asymmetric crater formation
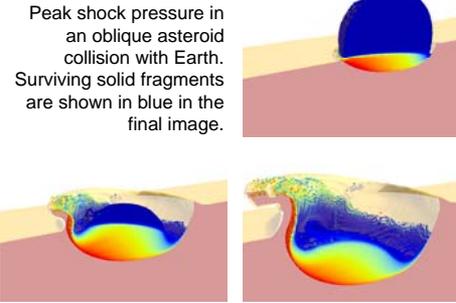
Peak shock pressure in an oblique asteroid collision with Earth. Surviving solid fragments are shown in blue in the final image.


Four time frames showing the shock wave travelling through a 10km diameter planetesimal following the impact of a 2.5km diameter impactor at 5 km/s (the direction of impact is down and to the left). Shock heating in such collisions was an important early solar system process.

## Adaptive Unstructured Mesh Technology
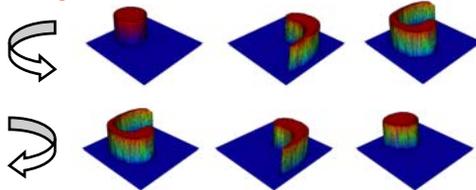
Material advection on unstructured adaptive meshes.
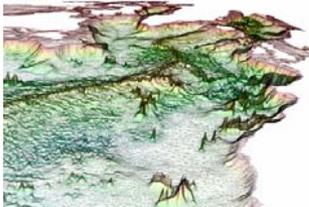
Unstructured meshes can be used to represent complex geometry e.g. Atlantic basin.

Water column collapse under gravity. Dynamic unstructured mesh adaptivity reduces computational cost of accurately modelling the process. Material advection maintains a sharp interface between the water and air.
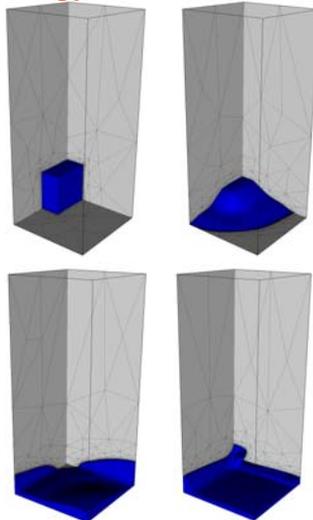
Landslide Generated Tsunami Waves
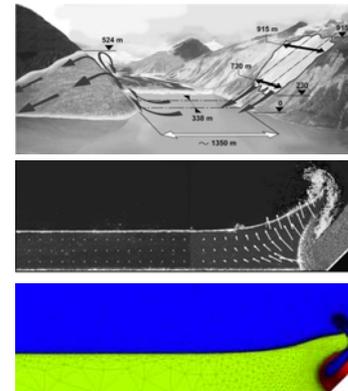
Lituya Bay, Alaska, 1958: Largest recorded landslide induced tsunami runup. Experimental models (Fritz et al., 2001) are now being used to validate our 2D wave generation models.
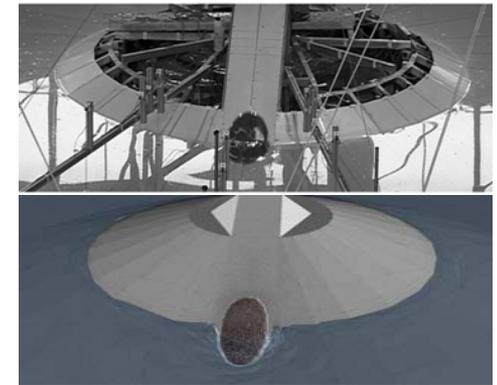
Stromboli, 2002: Landslide induced tsunami destroyed coastal infrastructure. Current 3D modelling of wave generation and propagation is building on previous laboratory scale models (DiRisio et al., 2009) of the event.