Constructive Interference of Seismic Surface Waves Antipodal to Crater Impact Sites on Terrestrial Bodies

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Asteroid impacts on planetoid bodies have been widely studied. A secondary effect that has been proposed due to these impacts is that the seismic waves should violently converge again at the antipodal point to the impact, 180 degrees away. There is geological evidence and computer modeling that support this converging wave theory, but it has never been directly observed in a laboratory experiment. The reason for this is that in rock, the compression waves propagate far too quickly (~3 km/sec) to be directly observable. The research described here solves this problem using a laboratory model by submerging a large (80 centimeter) balloon in water and striking it with a controlled impulse. Because the force modulus (surface tension of the latex membrane) is so small, and the inertial mass so large, the phase velocities of the surface waves are slowed down to the order of ~1 m/sec, and can therefore be visualized in detail. Gravity would ordinarily strongly distort a sphere with a tiny restoring force/mass ratio, but since the 270 kg water balloon effectively weighs nothing when submerged, gravitational deformation becomes a non-issue. Video taken at 240 frames per second of the resulting motion was then examined in slow motion. The slowed video very strikingly reveals the antipodal focusing effect. The observed wave motion was then compared with, and is in good agreement with, a theoretical one dimensional wave equation model. The video can be found here: https://youtu.be/bn6XMyTGWIY. It can also be searched for on YouTube as “Antipodal Focusing of Asteroid Impacts - First Visual Evidence.”

Awards Won:
Intel ISEF Best of Category Award of $5,000
First Award of $5,000
European Organization for Nuclear Research-CERN: Second Award of $1,500