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Acceleration of pyroclastic particles and high-speed impacts: numerical simulations.

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A steel basketball pole was the only object left standing in one village, 3.5 km from the crater, after the 1982 eruption of El Chichón volcano (Mexico). The surface of the object contains micrometer-sized craters attributed to the impact of ash particles (Scolamacchia and Schouwenaars, 2009) . Such particles consisted mostly of glass and crystals (hornblende, plagioclase, pyroxenes) ranging in size between 80µm and 280µm. Using the Bishop-Hill-Mott formula for penetration, Scolamacchia and Schowenaars (2009) estimated the velocity of impacting particles in a range between 710-980m/s. Such values exceed those normally reported for the speed of density currents generated during volcanic eruptions and they were therefore attributed to the acceleration of particles by shock waves arising from a momentum transfer from the gas to the solid phase. Shock waves are commonly generated during explosive eruptions at the vent by rapid decompression of the eruptive mixture. These waves in some cases can be also caused by magma-water interaction or by inside density currents which come from rapid change in the solid load due to topographic irregularities.
The aim of this work is to investigate numerically if following the passage of a shock the ash particles can achieve such high-speed values.
Initially we supposed that our ash particles don't influence on the gas flow. They move in the front of a shock-wave and have the same velocity as a gas. 1D problem of gas outflow to the void has been solved. It gives us the required parameters (mainly pressure) to obtain this high velocities. They will be used as a first assumption for CFD simulations. Further we studied the penetration of particles into steel plate. These simulations were made with a ANSYS AUTODYN code. We used particles with three different sizes(80 µm, 200 µm, 300 µm) and different shapes (spherical, cylindrical, and conical). The results were compared with real data obtained by T. Scolamacchia. It was found that for such small particles the shape has a great influence for penetrations. For particles with a small height to width ratio the rarefaction waves associating the incident shock wave destroy that particles before the penetration starts. For further studies we choose 2 simple shapes: sphere and cylinder (with H=2r). The last step would consist in 2D CFD simulation in INCA-CFD code. This will gave us more accurate parameters for shock waves acceleration. The results of these numerical simulations will be cross-checked with real experiments using a shock tube. Real volcanic CO_2 and SO_2 gas mixture in this experiments will be replaced by gases which meet requirements for conditions to use in the laboratory.

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