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Hazards by shock waves during explosive eruptions: preliminary results of experimental investigations.

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A recent study (Scolamacchia and Shouwenaars, 2009) investigated the nature of microscopic craters on the steel surface of a basketball pole left standing in one of the villages destroyed by the 1982 eruption of El Chichón volcano. The craters were attributed to the impacts of ash particles (70-280 μm) accelerated by shock waves due to an efficient momentum coupling with a gas phase, such that a sudden expansion of the gas, caused by shock wave propagation, drag the particles up to speeds of 710 to 980 m/s. Several open questions existed on this kind of phenomena.
Preliminary tests were performed to investigate the correlation between particle size and the high velocities calculated, based on inner deformation of the steel and crater geometry.
We used a shock tube apparatus consisting of a high-pressure (HP) steel autoclave, pressurized with Ar gas, and a low pressure (LP) tank at atmospheric conditions.
We used ash and lapilli bulk samples from El Chichón trachyandesites, and lapilli with random irregular shapes obtained by crushing and abrading dacitic blocks from pyroclastic flow deposits of Unzen volcano.
The samples were placed inside an autoclave at ambient T and P, located between the HP autoclave and the LP tank. Steel plates (same type of the original impacted material), were fixed to the LP tank walls, 10 cm above the autoclave that contained the samples. Shock waves were generated by the sudden decompression of the Ar gas due to the systematical failure of a diaphragm (which separate the LP from the HP section). Air expansion accelerated the particles from below toward the steel plate.
The speed of the particles was measured using a system of 4 copper wires conducting an electric signal. The signals dropped when the particles reached the wires.

We used low pressure ranges (3.1 to 9.8 MPa) for all experimental runs, obtaining a range of particles velocities between 40 and 257 m/s. These velocities can be attained by pyroclastic density currents.
Higher velocities (205 to 257 m/s) were obtained for smaller grain-sizes, in a range of fine lapilli-medium ash (2.8 to 177 μm). Lower velocities, 40 m/s to 85 m/s, were attained by medium (8 mm) and fine lapilli (4 mm), respectively. These values seem not directly related to the the material composition.
Impacts craters on steel plates were experimentally obtained, but we did not observe a modification of the steel inner structure, as observed in the original impacted pole. These results are in agreement with impacts occurred at low particle velocities, typical for gravity driven currents, as those reached in these experiments.
We observed a great reduction in grain-size of samples recovered after all experiments with respect to the original material. Such evidence coud be due not only to the disruption of grains when impacting the metal plate, but also to processes stricly related to shock wave propagation and gas expansion. These preliminary results need to be further investigated.