Transformation of blast-like hydrothermal jets into highly mobile pyroclastic surges. New insights from the August 2012 Te Maari eruption

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Cold (Bandai-type) pyroclastic surges are a particularly hazardous type of pyroclastic density current. They can comprise spectacular mobility in terms of their runout, their ability to surmount topographic barriers and their extremely destructive and lethal potential. In comparison to magmatic and phreatomagmatic/phreatic surges, our knowledge on the generation mechanisms and on the flow behaviour of cold surges remains largely fragmentary. The August 6 2012 eruption of Te Maari volcano, Tongariro (New Zealand), caused by the sudden decompression of the hydrothermal system below the crater, produced highly mobile cold surges that travelled and spread for 2.1 and 2.3 km along wide sectorial arcs to the E and W, respectively. In the W, surges reached and caused damage beyond the popular Tongariro Crossing Track, largely affecting Tourist businesses in the Central North Island of NZ until today.

Direct observations of the eruption, geophysical and geochemical monitoring data, and detailed mapping of the pyroclastic successions over the entire 6.3 square km surge inundation area allows: (a) a quantitative reconstruction of the eruption sequence comprising an initial debris avalanche, two surge units and associated ballistics strew fields related to two discrete and directed blast-like explosions that also formed the new fissure-type crater, and final fall deposits from a third, plume-forming explosion through the main Upper Te Maari vent; (b) a reconstruction of the surge generation mechanism through a longitudinal transformation of two high-velocity, discrete, blast-like hydrothermal jets expelled at 30 to 60 degrees to the horizontal; and (c) describing and interpreting associated transitional sedimentary facies changes along the main blast or surge sectors from massive breccias, a three-partite surge bed succession over a narrow, medial region with anti-dune formations and a wider distal region of normal dunes and planar surge forms.

Here we will give a brief description of the eruption sequence. We will show and discuss detailed quantitative datasets of the laterally and longitudinally evolving surge bed forms including dune and bed geometry data, deposit distribution, grain-size, particle density and componentry data and relate these to the explosion mechanisms at source, to the space- and time-variant formation of a highly density stratified surge, and to local interaction with 5 successive ridges and valleys in the surge runout path.

Through integrating surge thickness and grain-size data we will also present computations of the bulk/initial grain-size distribution of the two hydrothermal blasts/surges. This rarely obtainable piece of information will be used to model the absolute, vertically and longitudinally variable mass partition of the stratified surge flow. The model allows us to finally discuss general aspects of surge transport and deposition as well as surge destruction behaviour that is characteristic for mobile cold surges.