PYROCLAST FLOWS AND SURGES: POSSIBLE ANALOGY FOR CRATER EJECTA DEPOSITION. H. Hargitai[1], A. Kereszturi ([1]Dept. of Physical Geogr., Email: hargitai@emc.elte.hu, Dept. of Physical and Historical Geol., Eötvös Loránd University of Sciences, H-1083 Budapest, Ludovika tér 2., Email: krub@freemail.hu)

Introduction: We analyse a possible modell of the crater ejecta development and deposition with pyroclastic flows and surges. Because several of their characteristics and depositional structures are known and observable on the Earth it is useful to try to find resembling phases of the crater ejecta formation.

The modell: We analyzed similarities and differences of physical parameters between pyroclastic flows and crater ejecta formation. At volcanic eruptions the p, T are lower than at the moment of impact. In the origin of the pyroclastic flows we can analyse the physical circumstances at really explosive eruptions like Krakatoa-type eruptions too. The 1st seconds of the impact – contact/compression stage (CC), the kinetic energy is transfered to the rock by schock waves. In our analogy we ignore this phase because the differences are too large. The original energy is lost fast because of the expanding shock front and the conversion of the energy to heat, rock deformation etc. When the pressure drops to 1-2 GPa it behaves like normal seismic waves. [1] Heat melts the projectile and target rock layers, which is mixed to partly melted and brecciated target rocks.

At the end of the excavation stage [E] the ejecta material (the near surface ejecta curtain) falls out of the rim of the crater and its material flows away and settles down. At pyroclastic flows and surges originally high central pressure formed the fragments which later was transported by gravity at slopes. At a crater formation the impact explosion gas schock waves, reflected waves drive the upward movement of the debris. We can use the analogy at that point where the effect of the central pressure is lower and gravity driven current movement is important. Our analougue is best in the modification [M] stage when the transient crater reached its final dimensions and no more material is ejected. The ejecta blanket is now "in the air" and starts falling down. From this point the physical parametrs of this material is more or less similar to the ones in a volcanic eruption. By this time, the crater rim is higher then the surroundings so there is a slope corresponding to a volcanic dome that makes the flow movement possible.

In pyroclastic structures several distinct layers are identifiable. A crater ejecta structures can be taken as one cycle of a pyroclastic structure. The cratering process is ended after the solid materials fell down, with the finer particles gravitational settleing and the fallout of the solidified materials that were vapourized during the impact. The resulting distal ejecta can be extended to a global scale. These later stages are also analogues to the volcanic eruptions.

Characteristics	Pyroclastic flows	Pyroclastic surges	Crater ejecta emplacement
Temperature	900-1100 K and lower	900-1100 K and lower	1000-2000 K and lower
Pressure	first in the order of Mpa, later near to the atmospheric	firstly in the order of MPa, later near to the atmospheric	first [CC] in the order of GPa, later [M] nearly near to the atmospheric
Fragments	Mostly solid with gas and very few liquid phase	large gas content with lower solid matter ration	Solid phase and gas, with more plastic components (melts) Melts from projectile/target; solid rocks from target area, vapourized gas from projectile/target
Depositional structures	Poorly sorted and bedded, graded basal zone, trains of large fragments, alternating coars to fine graded layers, oriented fragments, at pumice inverse grading	laminated, cross bedding, lenses of well-sorted-rounded pumice lapilli, better sorted, no very fine and very coarse fractions	Fallout partly influenced by flowing movements
Driving force	gravitational induced movement on slopes	gravitational induced movement on slopes	first the gas pressure of the explosion [E], later gravitational induced motion on slope
Topography	relative high slope angle	relative high slope angle	nearly no originally slope, only in the late phase of the deposition low slope angle (from the rim)
Origin	collapse of the ejecta containing (simetimes km high) gas column above the central vent	mostly explosion driven fallout of ejecta, and later the collapsa of shorter gas driven explosion column	fallout (ejecta) from the central explosion
Duration of material upload	several hours/days?		Few seconds
Source of gas content	eruption column; outgassing of melt	eruption column; outgassing of melt; water of crater lake	vapourized projectile (if comet, more) or rock, in situ ground- or surface water or ice; outgassing of melt; On Venus: atmosphere
Speed	ejected material: 200-600 m/s; flow: 100-200 km/h	flow: 100-200 km/h	ejected material: 500 to several 1000 m/s

Comparison of flows, surges, crater ejecta

It is a question whether there is an eruption column at the impact site. In the case of volcanoes, the eruption column is supported by the continuos gas thrust from the crater which is not the case at impacts where the process takes place for few seconds. Observations of nuclear explosion tests show both eruptive coloumns and gasious flows just like surges too. [3] The ejecta blanket is partly fluidized by water.

The atmosphere is important with its pressure for the gas content inside the pyroclastic flow. At the crater ejecta in the depositional phase the difference between the atmospheric and the internal pressure is relative low – just like at a pyroclastic flow. Because pyroclastic structures are known from airless body our analogy can be used at the crater ejecta deposition on airless bodies, eg. on moons. Higher gas content cab make fluidization. On Venus, the long-run ejecta flows were spread in a fluid manner, extending beyond the continous ejecta, moving on a fluidized "bed" which are linked to impact melts, impact angle [2] and dense atmosphere.

Conclusion: In the late phase of the crater ejecta formation pyroclastic flows can be used as an analogy in the analysis of physical circumstances in the flow (flow regime, temperature, gas content, ration of liquid phases). The depositional structures can suggest to the density of the debris and fallout style/time.

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