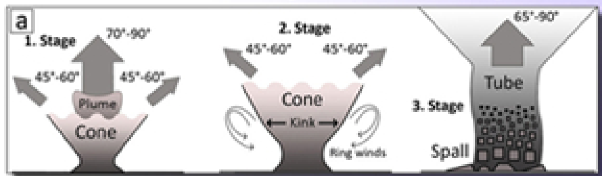
FRAGMENTATION AND EJECTION BEHAVIOR IN IMPACT EXPERIMENTS – THE MEMIN PROJECT

Frank Sommer[1], Tobias Hoerth[2], Michael Poelchau[1], Thomas Kenkmann[1], Alex Deutsch[3]

[1]Department of Geology, University of Freiburg - Germany/ [2]Fraunhofer-Institute for High-Speed Dynamics, Freiburg, Ernst-Mach-Institut (EMI) - Germany/ [3]Institut für Planetologie, Westfälische Wilhelms-Universität Münster - Germany

1. The ejection process

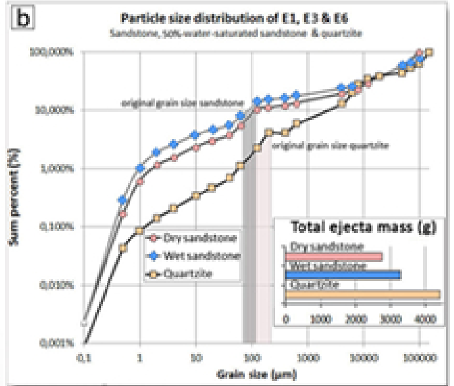
This project examines the influence of the target properties porosity and water-saturation on mass, mass distribution, particle size distribution and velocity of the ejection process. Quartzite with 1% porosity and sandstone with 23% porosity, dry and water-saturated, were impacted with iron projectiles (Ø 12 mm) at 4.6 km s-1 velocity. The ejection process starts with the plume stage directly followed by the cone stage and the tube stage (a).

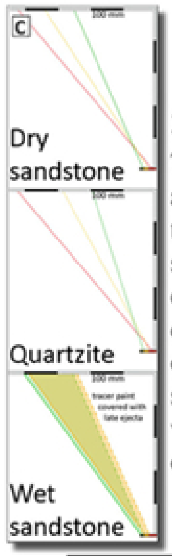


2. Mass and particles size distribution

After the impact the ejected material is collected weighted and sieved. Increasing target density leads to increased total ejecta mass. On porous material the influence of the original grain size is stronger whereas water saturation causes greater comminution (b).

For more detailed examinations the Vaseline catcher, the phenolic foam catchers and the high speed videos are examined.



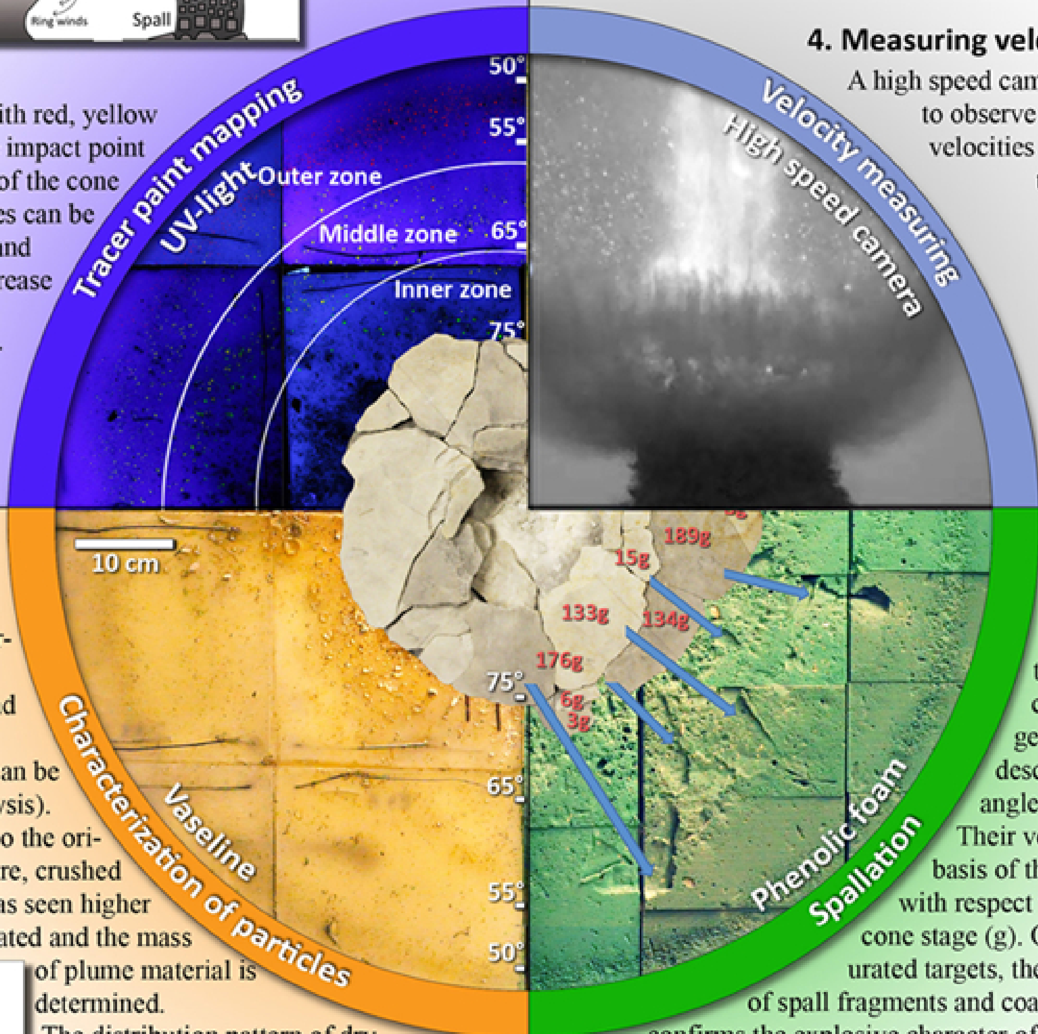


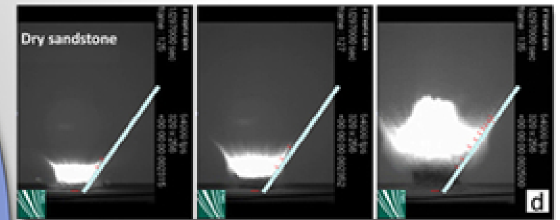
3. Cone ejecta angles

The target blocks are prepared with red, yellow and green tracer paint around the impact point to reconstruct the particle tracks of the cone stage. Using UV light the particles can be easily identified. Dry sandstone and quartzite display a consistent increase of the cone angle, wet sandstone shows a spray-like ejection behavior leaving off the central area of the catcher (Fig.c).

4. Measuring velocities

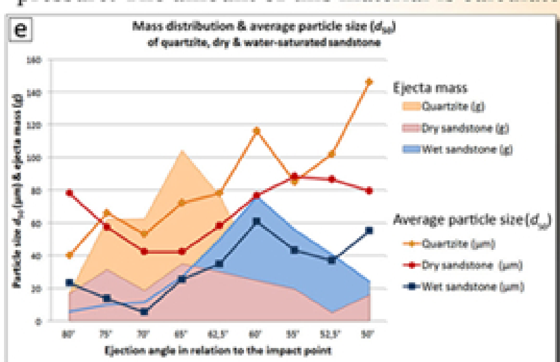
A high speed camera with 54000 frames per second was installed to observe the ejection process. The estimation of the peak velocities by measuring the visible ejecta front shows that targets with 23% porosity have lower velocities (2.5 km s^{-1}) than water saturated (3 km s^{-1}) and non-poros targets (3.5 km s^{-1})(d).



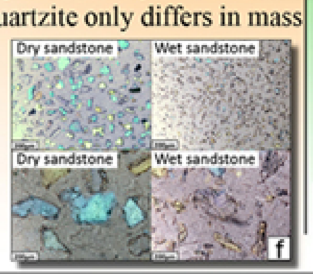


5. Distribution and characterization of plume and cone material

The Vaseline catcher mainly collects cone and plume material up to 5 mm which can be separated by the particles size. With this data, mass distribution (e), particle size distribution (e) and particle characteristics (f) during the ejection process are analyzed. The first cone particles can be found in the outer-most area (tracer paint analysis). Their particle sizes and distribution is similar to the original grain size of the sandstone (b,e). Therefore, crushed quartz is ascribed to the plume stage since it has seen higher pressure. The amount of this material is calculated and the mass of plume material is determined.

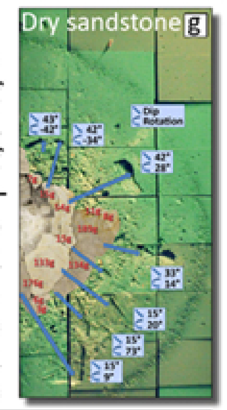


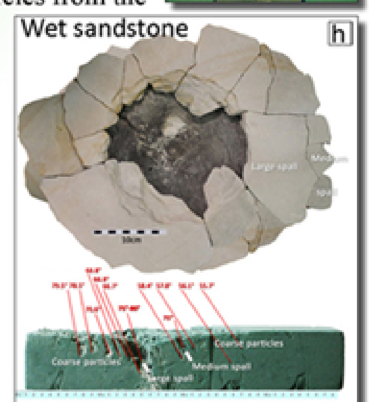
The distribution pattern of dry sandstone and quartzite only differs in mass but wet sandstone shows its mass peak in the outer area and a lower particle size at all positions (e).



6. Spallation

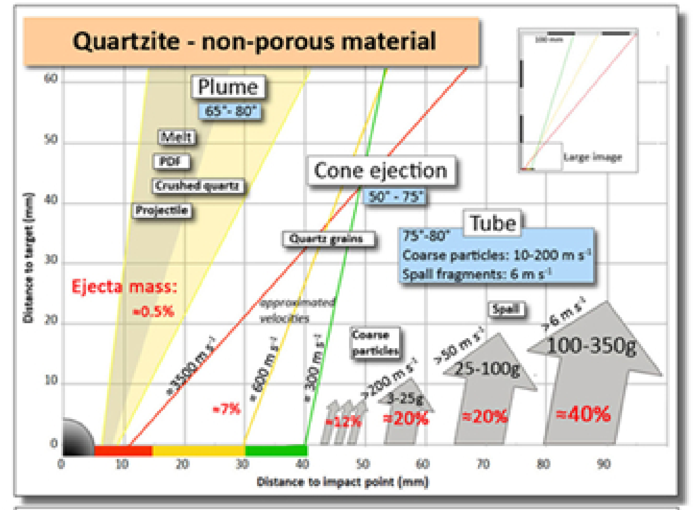
Phenolic foam catchers preserve the imprints of large spall-fragments and the penetration channels of coarse particles. On dry targets, the imprints are used to describe the track and ejection angle of the fragments in detail. Their velocity is calculated on the basis of their gravitational deviation with respect to faster particles from the cone stage (g). On water saturated targets, the distribution of spall fragments and coarse particles confirms the explosive character of the ejection process (i).

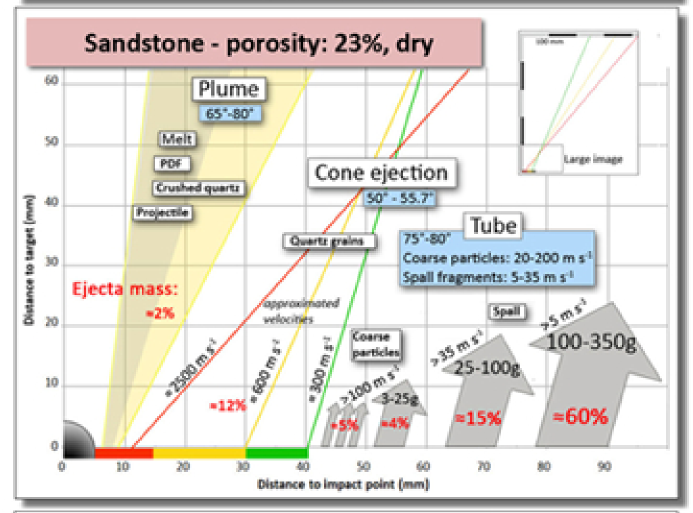


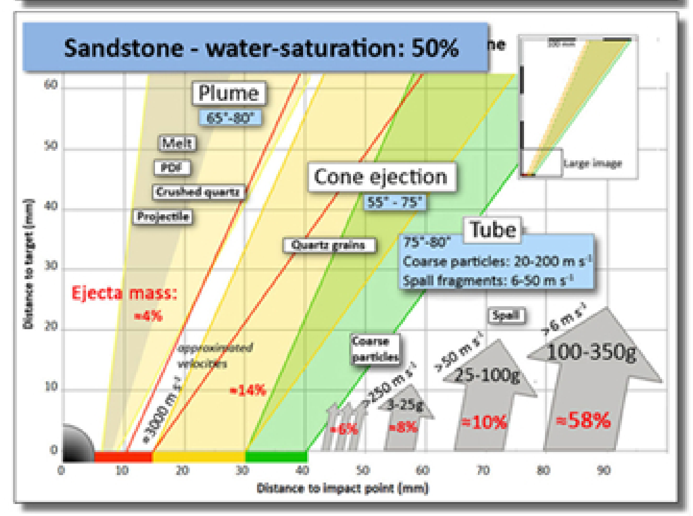


The combined results from the different examinations allow a detailed descriptions of the ejection process and its changes due to different target properties → 7.

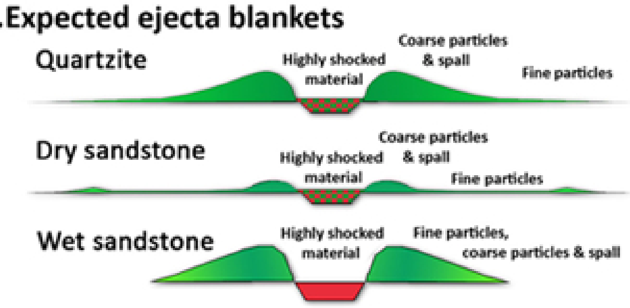
7. Ejecta behavior in dense, porous and water saturated material at identical impact parameters (4.6 km s-1; 12 mm steel projectile)







8. Expected ejecta blankets



9. Summary

The target properties considerably change the ejection process:

- **Porosity** reduces the **total ejecta mass** (b).
- **Porosity** decreases the ejection **velocity** (§4).
- **Water-saturation** increases the total ejecta mass and ejection velocity (b,§4).
- **Volatiles** add an explosive element to the ejection process. They increase the degree of **comminution** (e,ft) and change the **ejection behavior** (c).
- In **dry experiments** the ejecta cone steepens before it is replaced by the tube column, in **water saturated experiments** cone and tube merge into each other (e,g,h).

frank.sommer@geologie.uni-freiburg.de