

## ***SUMMARY OF SESSION ON EJECTA PLACEMENT AND OBLIQUE IMPACT EFFECTS, SATURDAY, FEBRUARY 8, 1:50 P.M.***

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*Summary by H. J. Melosh*

This session included five talks dealing with oblique impacts. The talks ranged from theoretical computations with three-dimensional numerical codes, to experimental studies, and then to field observations.

The most theoretical talk was presented by Natalia Artemieva of the Institute for the Dynamics of Geospheres in Moscow. She collaborated with Betty Pierazzo (Planetary Science Institute, Tucson) on a study of the ejection of melted materials from the Ries impact crater. Using the 3-D hydrocode SOVA, they showed that melt originating from near the surface of the target was ejected in two streams concentrated on either side of the down range projection of the impactor's flight path. This pattern matches the observed location of the moldavite tektite strewn field very well. She also discussed scaling of melt production in oblique impacts and the origin of Martian meteorites. Discussion after the talk focused on the actual depth of origin of the tektites and how they achieved their distinctive geochemical signatures. Later, Pete Schultz stated that he has formed similar ejecta patterns experimentally.

Pete Schultz, of Brown University in Providence, then described his experimental investigations of oblique impacts in the presence of an atmosphere. He argued that the distinctive Martian rampart crater ejecta pattern was created by vortices produced by the collective interaction of ejecta and the ambient atmosphere. Discussion following the talk focused on how to scale from the laboratory to the Martian surface, and the possible importance of vaporization of ice in the target.

Robert Herrick (with co-author K. Hessen), of the Lunar and Planetary Institute, Houston, presented observations of oblique impact craters on a planetary scale. Comparing data from lunar, martian and venusian crater populations, he found that the wall slope of these craters does not depend on the angle of the impact. He also found similar numbers of highly oblique craters on all these bodies. In the discussion Schultz warned that the pre-existing topography of

the target may play an important role in the final crater morphology.

Jennifer Anderson (with co-authors Pete Schultz and J. T. Heineck), of Brown University in Providence, extended the Maxwell Z-model of cratering flow to oblique impacts by fitting the model to ejecta distributions that she measured experimentally using her innovative PIV (3D Particle Image Velocimetry Technique) laser technique. The Z-model does not seem to do a very good job: Even for vertical impacts it requires a moving source to fit the observations. Most listeners agreed that the Z-model is too simplistic to be used for detailed predictions of ejecta distributions.

Larry Haskin and Bill McKinnon, of Washington University in St. Louis, presented a model for the emplacement and distribution from very large impact basins on the Moon. This talk raised the still unsettled problem of how many and how large are the secondary impacts from large impacts on the Moon, a topic that was aired extensively in the following discussion.

Finally, Francis Macdonald (with K. Mitchell), from Caltech in Pasadena, intrigued the conference participants with the report of a large ( $20 \times 12$  km) region of shatter cones discovered in a remote region of Australia. The area is tectonically complex, but no central peak, which is expected in this size impact structure, is evident. Macdonald proposed that this is a very oblique impact crater. The discussion reflected great interest, but more study is clearly necessary before this interesting structure is understood.

The session concluded with about half an hour of general discussion that ranged over the topics raised in the talks. It was clear that the subject of oblique impacts was of high general interest, but that much more remains to be learned about its implications for impact craters and impact ejecta. Theory, experiment and observation of both terrestrial and extraterrestrial craters all have important roles to play.