GROUND PROBING RADAR SURVEY OF THE EJECTA BLANKET AT METEOR CRATER ARIZONA.
J.Pilon[1], R.A.F.Grieve[1] and V.L. Sharpton[2]. [1]Geological Survey of Canada, Ottawa, Canada, [2]Lunar and Planetary Institute, Houston, TX., U.S.A.

Current knowledge of hypervelocity impact cratering draws heavily upon ground-truth data from terrestrial impact structures, particularly for the nature of subsurface lithologies and structure. Previously we presented the results of a Ground Probing Radar (GPR) survey within Meteor Crater, Arizona (1). Here, we extended this work to a 100 MHz, GPR survey across the exterior ejecta blanket. The 700 m long survey was in the NE sector of the crater and extended radially inwards from near the distal edge of the ejecta, terminating close to the museum buildings. The experimental conditions emphasized near surface information: frequency 100 MHz; antenna separation 1 m; step interval 1 m; time window 512 nanoseconds; sample interval time 800 picoseconds, which yielded 640 points per trace. Each trace was a stack of 512 pulses. One Common Mid Point sounding yielded a propagation speed of 10 $cm.ns^{-1}$. There is approximately 55 metres of topographic relief along the exterior transect. A datum of zero elevation was created at the first station and a topographic correction was applied to the following stations by shifting the radar traces by the appropriate elevation differences.

The most obvious feature on the topographically corrected radargram (Fig.1) is a near surface layer, consisting essentially of point sources generating strong returns. The base of this layer is at 75 ns (3.8 m) at the distal end of the traverse and reaches a maximum of 175 ns (9.5 m) some 50 m from the crater rim. This layer of point sources is interpreted as the fragmental material of the ejecta blanket. Its contact with the underlying layer is relatively sharp and its thickness compares favorably with that determined by drilling, about 3 m at 700 m and 10 m at 200 m from the rim on a NE traverse in the same general area (2). The ejecta blanket layer pinches and swells with local thickness variations of several meters (Fig. 1). Although it thins with distance from the crater rim, its thickness variation does have a smooth decay function (3). We attribute this to scale, with the pre-impact surface topography exterior to the crater, combined with surface erosion effects, being a reasonable fraction of its thickness.

Beneath the ejecta layer is a relatively quiet zone with few reflectors. We interpret this as the in situ Moenkopi sandstone, which according to drilling averages 8.5 m, with a minimum of 1 m beyond the ejecta blanket in the northeast (2). Away from the immediate area of the rim, the section interpreted here as Moenkopi varies in thickness between 8 and 1 m (Fig. 1). There are a series of strong, essentially continuous reflectors beneath the Moenkopi. We interpret the uppermost as the Moenkopi-Kaibab contact and the others as bedding within the Kaibab. In several places, these horizontal reflectors are interrupted and displaced by faults (Fig. 1). The maximum throw on the faults is 4 m and they appear to decrease in dip to ~ 20° at ~ 200 m from the rim, where it is clear that they are reverse faults (Fig. 1). The very strong downward parabolic reflectors around 80 m from the rim are side-lobe reflections from power lines (Fig. 1).

The Moenkopi-Kaibab contact remains sub-horizontal to ~ 400 m from the rim (Fig. 1). Interior to the fault at this distance, the apparent dip of this contact increases to ~ 5°. The next tilted block has an apparent dip of ~ 8°. This block is bounded by a fault ~ 70 m from the rim. Interior to this, the apparent dip increase to 25-30°. Fig. 1 has a vertical exaggeration of 8:1, in order to display the entire line at a reasonable scale. This exaggeration masks the geometric relationships near the rim. The final 50 m of the transect near the rim have been replotted with no vertical exaggeration (Fig. 2). It shows a series of thrust faults with throws of up to 1 m. The throw of these faults appears to increase as the rim is approached. A number of exposed thrust faults are recognized inside the crater rim on the north side (4). The thrust faults identified on the radar transect are likely their extension.

From the radar profile, structural uplift of the rim area at Meteor Crater is due mainly to block tilting (Fig. 1). Very little is accomplished by faulting and by what appears to be thrust faults in the immediate area of the rim crest (Fig. 2). Assuming ~ 20 m of erosion at the rim (5) the slumping suggested by the reverse faults when added to the present 55 m of topographic uplift gives an estimate of ~ 85 m for the height of the rim crest at the time of maximum transient cavity growth. This compares favorably with model estimates of ~ 82 m (6).

These results indicate clearly the utility of GPR for the detection of subsurface structure at impact craters. The depth estimates of various contacts agree with the results of drilling. The radar data, however, provide a two dimensional profile with considerably more detail than spot depths determined from drilling.

ACKNOWLEDGEMENT: Field work was in part supported by a grant from the Barringer Crater Company, receipt of which is gratefully acknowledged.

GPR SURVEY OF EJECTA AT METEOR CRATER, Pilon, J. et al.

REFERENCES: (1) Pilon et al. (1989), LPSC XX, 852-853; (2) Roddy, D.J, et al. (1975), PLSC 6th, 2621-2644; (3) McGetchin,T.R. et al.(1973), EPSL, 20, 226-236; (4) Shoemaker, E.M. (1974), Guidebook to the Geology of Meteor Crater, 66 p.; (5) Roddy, D.J. (1978), PLPSC. 9th, 3891-3930; (6) Grieve, R.A.F. and Garvin, J.B. (1984), JGR 89, 11561-11572.

Fig. 1. Topographically corrected radargram of radial traverse across ejecta blanket in NE of Meteor Crater. Radar data is at bottom, with a line diagram of interpretation above.

Fig. 2. Radargram of 50 m of traverse closest to rim with no vertical exaggeration. In lower, line diagram interpretation M-Moenkopi, K-Kaibab.