ASYMMETRY OF THE CHICXULUB CRATER – IS IT PRODUCED BY ASYMMETRY IN THE TARGET? J. Morgan[1], P. Barton[2], G. Christeson[3], S. Gulick[3], G. Collins[1], [1]Dept. Earth Science and Engineering, Imperial College London, UK, SW7 2AZ, j.morgan@imperial.ac.uk, [2]Dept. Earth Sciences, University of Cambridge, UK, CB3 0EZ, [3]Institute for Geophysics, Austin TX 78758-4445.

Introduction: In 1996 and 2005 we acquired extensive seismic reflection/refraction datasets across the Chicxulub impact crater (Fig. 1). These data reveal that both the crater structure and original target properties vary around the offshore portion of the crater. At this stage, it is not possible to decide whether the azimuthal variation in crater structure is related to: 1) target asymmetry, 2) impact angle or 3) a natural instability in crater formation. However, the correlation between structural asymmetries in the final crater and pre-existing geologic features of the target suggests influence by the target may be significant. Our aim, ultimately, is to test these different hypotheses using 3D dynamic modeling codes that are currently under development.

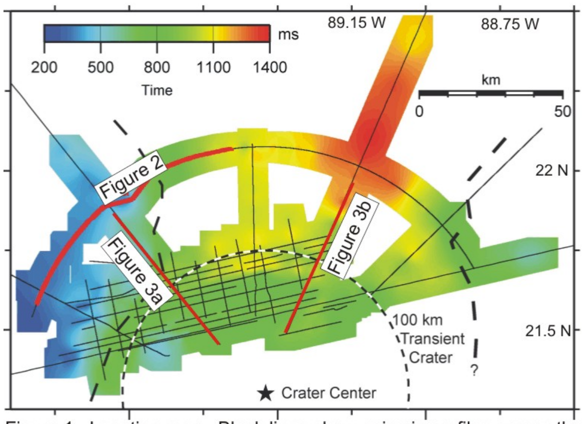

Figure 1. Location map. Black lines show seismic profiles across the offshore half of the Chicxulub crater. Color indicates two-way travel time to K-P boundary. The K-P boundary is relatively deep in the north and northeast, and shallow in the northwest, west, and onshore. The location of figures 2 and 3 are indicated in red.

Target asymmetry: We have imaged the near-surface Cretaceous sediments around the offshore portion of the crater. These data show that the Cretaceous sequence to the north and northeast of the crater is currently 1-1.5 km deeper than the same sequence to the northwest and west (Fig. 2) and also deeper than the Cretaceous sediments onshore, as determined from drill holes. The combined drilling and seismic data suggest that the impact was into shallow water, but that there was a relatively deep, water-filled basin in the north and northeast quadrant [1].

There is also evidence for the Cretaceous section thickening from onshore to offshore and from the east to the west [1, 2], whereas the crustal thickness appears to decrease from west to east [3].

Crater asymmetry: The most striking difference in crater structure imaged by seismic reflection profiles is the cumulative difference in offset on the Cretaceous target sediments across the terrace (megablock) zone. In the northeast the total offset is ~2 km, and in the northwest it is ~6km (Fig. 3) [4]. A second striking difference is the change in character of the crater's peak ring around the crater. It appears that the peak ring is generally broader and flatter in the north and northeast, and narrower and more topographically prominent in the northwest (Fig. 3) [5]. In addition, the innermost Cretaceous sediments are slightly deeper, and lie directly underneath the peak ring in the west and northwest, whereas they are slightly shallower and lie beneath the outer edge of the peak ring in the north and northeast. (Fig. 3).

Onshore, drill holes indicate that the K-P boundary deepens from ~500 m outside the cenote ring to ~1.2 km in the crater center. Reflection profiles to the northwest and east-northeast confirm this deepening of the impact basin. However, to the north and northeast, from the center of the crater outwards, the Tertiary basin gradually increases in depth. There appears to be no crater rim, as such, in this quadrant.

In the central crater, reflections from the Moho indicate that the base of the crust is uplifted by ~2 km [3, 6], and refraction data reveal a high-velocity-zone that is interpreted as central uplift [7]. However the Moho uplift and central uplift are offset from eachother, with the central uplift being southwest of the crater center and the Moho uplift being to the east.

Summary: There is a clear variation in structural features around the crater and variation in the pre-impact target: in the west-northwest the deeper and steeper terrace zone is associated with shallow Cretaceous bathymetry, while in the north and northeast the shallower terrace zone is associated with a deep, water-filled basin at the time of impact. However, it is difficult to know whether asymmetries in pre-impact target and final crater form are linked. Preliminary 2D hydrocode modeling does suggest that a thick versus shallow water and sediment layer could affect crater formation, and the final position of the terrace zone in particular. 3D hydrocodes are now under development [8] and with these codes we will be able to address, for the first time, the effect of asymmetry in the target on final crater form. Future 3D modeling of the formation of the Chicxulub crater will help us distinguish between the effects of both target asymmetry and impact angle on final crater form.

References: [1] Gulick et al. (submitted) Nature Geoscience. [2] Bell et al. (2004) *Meteoritics & Planet. Sci., 92,* 1089-1098. [3] Christeson et al., (2001) *JGR, 106*, 21,751-21,769. [4] McDonald (2007) Master's thesis, UTIG. [5] Mendoza (2007) Master's thesis, UNAM. [6] Christeson et al., (in prep). [7] Morgan et al. (2002) *Tectonophysics, 355*, 217-228. [8] Elbeshausen et al., 2007. LPSC XXXVI, Abstr. #1952

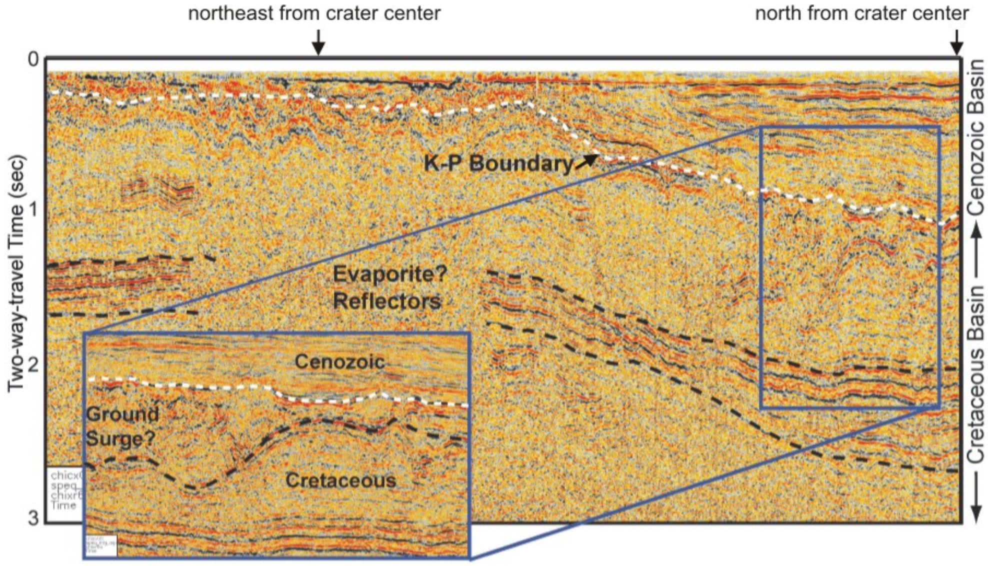

Figure 2. Offshore seismic reflection profile. The Cenozoic basin is unusually deep in the north and northeast quadrant of the crater, and the thickness of the Cretaceous sediments increase in this direction. See Figure 1 for location.

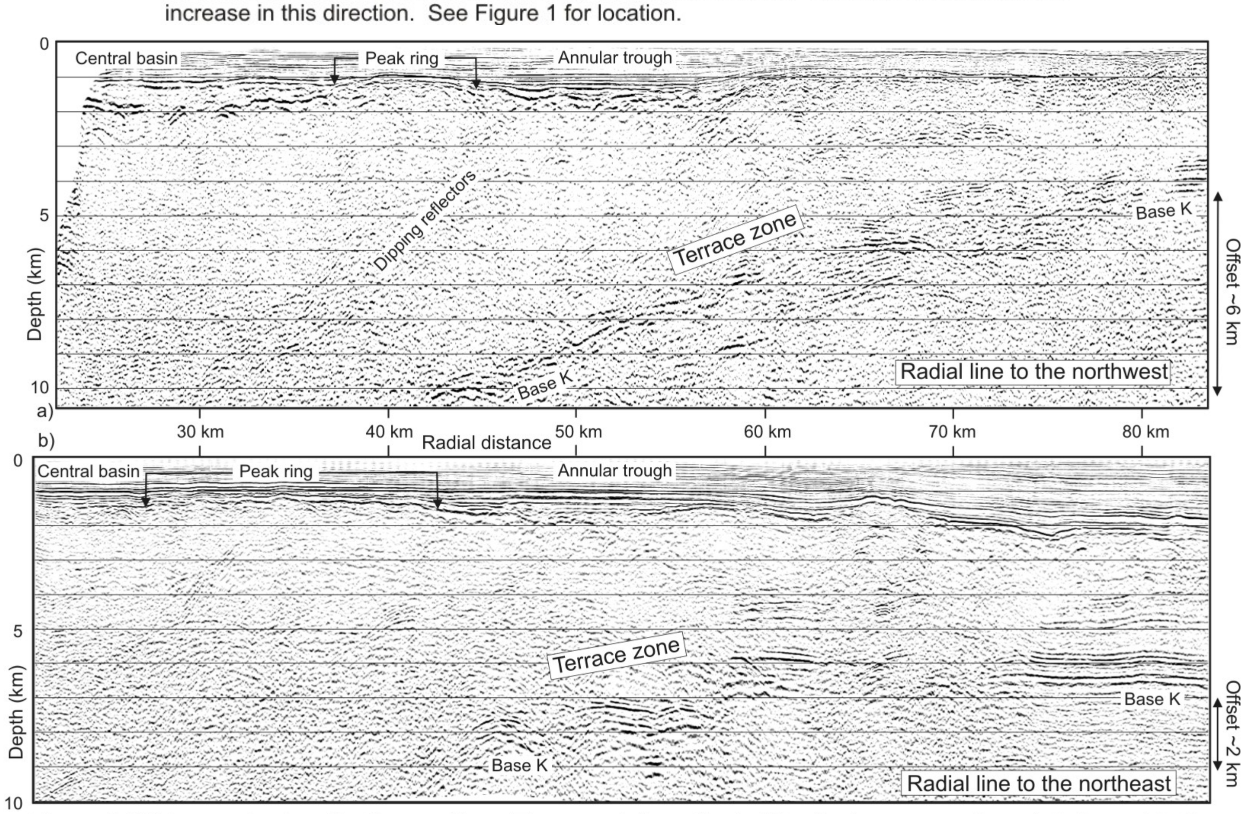

Figure 3 Offshore seismic reflection profiles. The cumulative offset of the Cretaceous sediments is largest in the northwestern quadrant of the crater, and smallest in the northeast. See Fig. 1 for location