CHICXULUB REVEALED WITH NEW SEISMIC AND GRAVITY DATA. Joanna Morgan[1], Anneka Smith[1], Elinor Styles[1], Anusha Surendra[2], Penny Barton[2], [1]Dept. Earth Science and Engineering, Imperial College London, SW7 2AZ, UK, j.morgan@imperial.ac.uk [2]Dept. of Earth Sciences, University of Cambridge, CB3 0EZ, UK.

Experiment:
In early 2005 we acquired a new high-resolution grid of seismic and gravity data across the Chicxulub impact crater (Fig. 1). These data include ~1500 km of reflection profile, ~36500 airgun shots that were recorded on 28 ocean bottom seismometers and 87 land seismometers, and ~7600 km of gravity data. Data are being processed at UTIG (University of Texas at Austin Institute for Geophysics), and the Universities of Cambridge and Imperial in the UK. Some targets of the experiment are: to map the extent and asymmetry of the slumped Cretaceous blocks around the crater, to determine the extent of the anomalous low velocity zone beneath the peak ring, to map the extent and shape of the stratigraphic uplift, to investigate changes in ejecta thickness around the crater, and to collect site survey data for two proposed IODP drill holes.

Background:
Chicxulub is the most pristine large impact crater on Earth as it has been largely unaffected by post-impact erosion and tectonic deformation. Chicxulub is the only crater on Earth that displays an unequivocal peak ring, and it is the only crater with a global ejecta layer. In addition, there are ejecta deposits outside the crater and impact breccias within the crater basin. Hence Chicxulub is a unique natural laboratory and assumes a crucial role in providing information on the cratering process and the global effect of a large-scale impact event. However, the crater is buried ~1 km beneath the Earth's surface, and thus the only way to map this crater is through geophysical investigations and drilling. There is now seismic reflection, seismic refraction, earthquake, gravity, magnetic, and magnetotelluric data across the crater, as well as a number of holes drilled by Pemex (Petróleos Mexicanos) and UNAM (Universidad Nacional Autónoma de México). After initial disagreement about the size of the crater, a 1996 seismic survey led to a consensus that Chicxulub was 180-200 km in diameter. In February 2002 Chicxulub was drilled onshore at Yaxcopoil-1 under the International Continental Scientific Drilling Program (ICDP). Although outer crater structure is now reasonably well constrained, current lithological and structural models of the central crater remain diverse. This diversity is partly due to the inherent ambiguity of interpretations of geophysical data, and partly because there are no deep drill holes that can ground-truth our models. We will use our new seismic and gravity data to produce a more accurate model of the crater; the accuracy of which will be greatly improved with a new deep drill hole in the center of the crater.

Results and future work:
We present new tomographic velocity data across the peak ring, and the new marine gravity data. To date the offshore gravity has been of lower resolution than that onshore, and ring features identified in the horizontal gradient of the gravity have been clearer onshore than offshore. Additionally, we have high resolution seismic reflection data only offshore, and drill holes only onshore – hindering past efforts to map crater structure from offshore-onshore. The new gravity data shows the offshore rings more clearly, and the new reflection data allows us to determine the relationship between structures identified on the reflection data and their velocity, gravity and magnetic signature. Hence, for the first time, we can confidently map features from onshore to offshore. We see a clear relationship between the innermost slump

block and the gravity data (dashed yellow circle), and the peak ring (transparent red zone) and the potential field data (Figure 1).

A proposal exists to drill through the entire melt sheet and/or peak ring, and is a possible joint venture between ICDP and IODP. The purpose of the central hole (ICDP-2) is to penetrate the melt sheet and into the stratigraphic uplift, to characterize the melt rocks within the central basin. These data, along with the geophysical data, will be used to calculate the total volume of melt produced and to constrain the energy of impact. Geochemical analyses of the melt rocks and stratigraphic uplift will be used to constrain target lithology, and search for a chemical signature of the meteorite, and to determine the depth of origin of the basement rocks that form the stratigraphic uplift. IODP-2 will drill into the crater's peak ring, documenting the lithological and structural character of this ring, and test competing models for its formation. Chicxulub is a critical example in this regard, as it is the only known large terrestrial impact basin that has a preserved original peak ring. Understanding the mechanism for peak-ring formation is fundamental to understanding the mechanics of cratering.

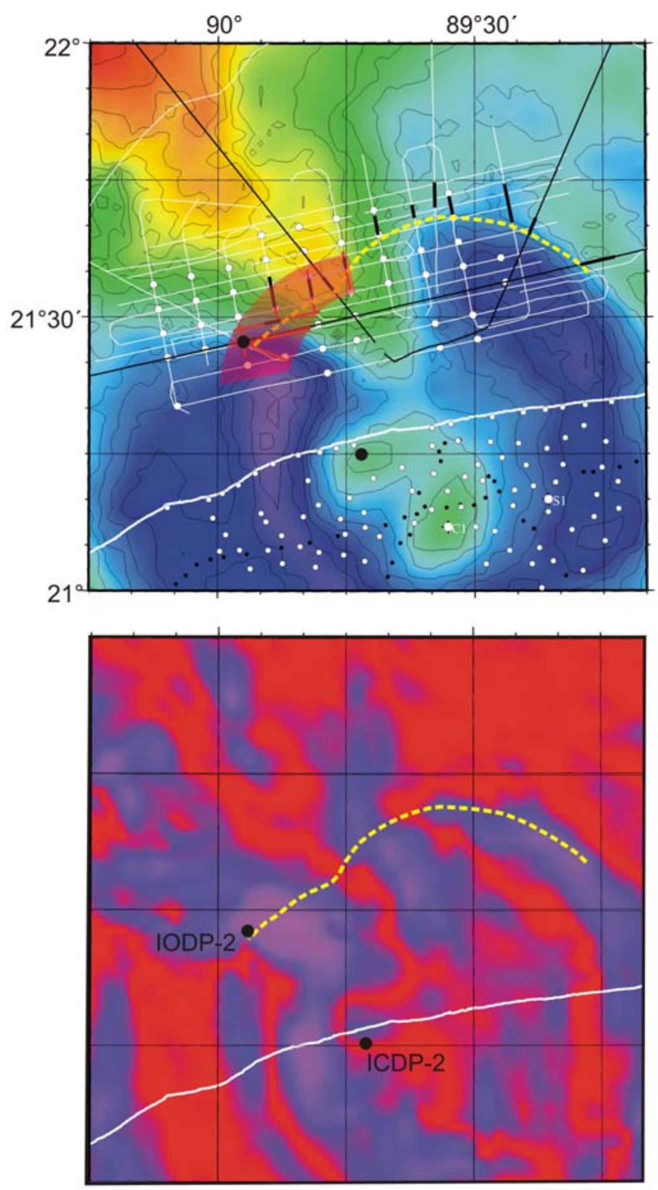

Figure 1
The top figure shows the experimental geometry and the new gravity data. White solid lines are new reflection profile, black lines are the 1996 data. Airgun shots were recorded on ocean bottom and land-based seismometers which are indicated by white dots. Small black dots show the location of the 1996 stations. The thick white line is the Yucatan coast; S1 and C1 are two Pemex drill holes that reached the crater floor. The dashed yellow line represents the innermost location of the slumped blocks of Cretaceous, which correlate well with the outer edge of a gravity low (colored pink).

The bottom figure shows the horizontal gradient of the gravity; blue represent zones where gravity is changing rapidly. The two large black dots are possible sites for drilling.

Acknowledgments
The survey was funded by NERC and NSF. We acknowledge the efforts of our Co-PIs, Jaime Urrutia, Mario Rebolledo, Mike Warner, Sean Gulick and Gail Christeson, and the large party of scientists who helped to acquire these data, in particular Matt McDonald and Keren Mendoza who contributed to the processing of the seismic reflection data.