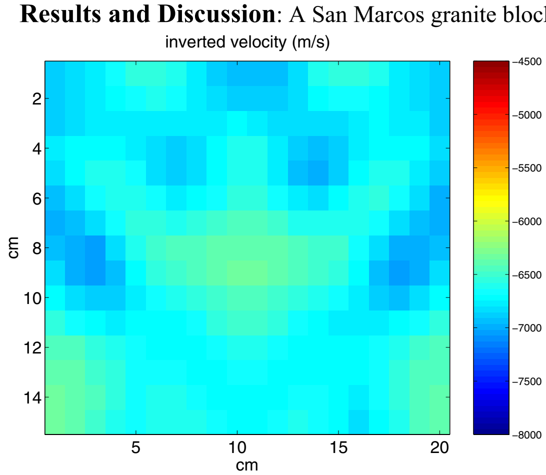
SHOCK-INDUCED DAMAGE BENEATH NORMAL AND OBLIQUE IMPACT CRATERS. H. Anita. Ai[1] and Thomas. J. Ahrens[2], [1]Caltech, 252-21, Pasadena, CA, 91125. ahr@gps.caltech.edu, [2]Caltech, 252-21, Pasadena, CA, 91125. tja@gps.caltech.edu.

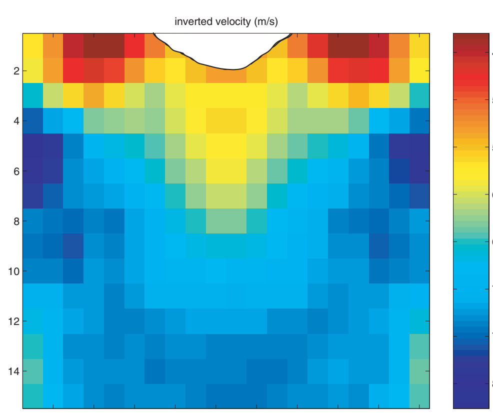
Introduction: Craters produced by oblique impact at impact angle greater than 30° (90° means vertical impact) usually show a circular shape [1]. Because of this, crater dimensions provide little information about the impact angles. Recent study indicates that the large scale impact-induced reductions in compressional velocity beneath impact craters is an important feature for constraining impact history. A series of small-scale normal and oblique impact experiments are conducted on San Marcos granite and Bedford limestone. The damage beneath the craters of granite are mapped by a non-destructive tomographic method. For limestone, cubes are cutted from the recovered targets and measured separately.

Results and Discussion: A San Marcos granite block before impact is mapped using the tomographic method [2]. Figure 1 shows the inverted result for the pre-shot target. No obvious heterogeneity is observed from the result. However, from the velocity profile of the post-shot target impacted by a lead bullet at velocity of ~ 1.2 km/s, the low velocity zone is observed and extended to ~ 7 cm (Fig. 2b).

An oblique impact (impact angle 45°) is performed while keeping all the other conditions the same. Two P-wave velocity profiles, one along the projectile trajectory path, referred as surface 1, another across the projectile trajectory, referred as surface 2, were mapped. The craters for both the normal and the oblique impacts are circular except that the oblique one



(a)



(b)

Figure 1: Smoothed P-wave structure of the center plane for (a) the pre-shot target; (b) the normal post-shot target. Actural crater shape is shown.

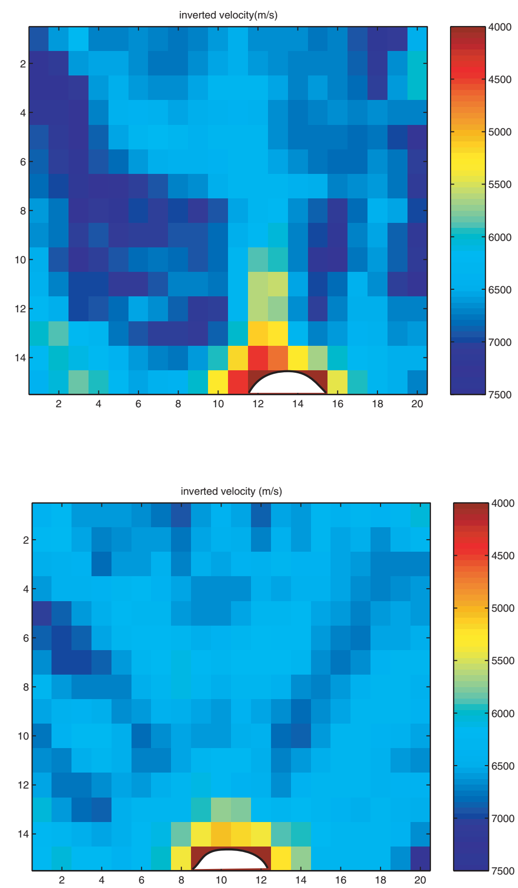


Figure 2: Smoothed P-wave profiles of the two planes for the oblique impact. (a) surface 1, along the impact direction, asymmetry is observed; (b) surface 2, normal to the impact direction, no asymmetry is observed.

is smaller than the one formed by the normal impact, which means that the crater dimension itself cannot constrain the impact angle. However, Asymmetry is observed from P-wave velocity inversion of surface 1, but not from surface 2 (Figure 2). And the downrange shows more damage than the uprange. This result agrees with the peak shock pressure calculation of oblique impact [3]. The damage depth is ~ 3 cm from both profiles.

Measurement of compressional velocities for the cubes of Bedford limestone (normal and oblique impact) is in process.

Conclusion: Our results show that the shock-induced damage region depends on impact energy and the impact trajectory. We presume that planetary scale impact structures carries both impact velocity and direction not previously recognized or sought. The damage profile measured by seismic velocity deficit beneath craters add new and significant constraint on impact history.

References:

[1] Gault D. E. and Wedekind J. A. (1978) *Proc. Lunar Planet. Sci. Conf.* 9: 3843-75. [2] Pilkington M. and Grieve R. A. F. (1992) *Rev. of Geophys*, 30, 161-181. [2] Ai H. A. and Ahrens T. J. (2004) *Lunar Planet. Sci. abstracts:* # 1979. [3] Pierazzo E. and Melosh H. J. (2000) *Annu. Rev. Earth Planet. Sci.* 28: 141-167.