AN EXPERIMENTAL TOMOGRAPHY STUDY OF IMPACT-INDUCED DAMAGE BENEATH 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: Large scale reductions in compressional velocity caused by impact-induced damage is an important but largely unstudied feature of impact craters [1]. Damage depth beneath impact craters can be used to extract information about the impact cratering process. A new non-destructive method is developed to study the damage structure beneath impact craters in the laboratory.

Experimental setup:

(1) Rifle shot: To produce the crater in the target, a 0.220 inch caliber rifle is used to launch the commercial lead bullet into the San Marcos granite block, with dimension of 20x20x15 cm, and density of 2.657 g/cm^3. Two breakwires are placed on the path of the bullet for velocity measurement. The impact velocity of this shot is ~1200 m/s. The initial pressure of this impact is calculated using impedance match method [2].

(2) *Tomographic set up*: a 2-D tomography method is used to study the shock-induced velocity reduction in the recovered target [3]. Fig. 1 is the tomographic ray diagram. A tungsten carbide ball (diameter 0.08 cm) is launched by a laboratory constructed air gun to produce the source wave. The new apparatus allows 1-cm spatial resolution and velocityr resolution of ±0.2 km/s. Two P-wave transducers are used; one is placed next to the mechanical source, the other is placed on the surfaces of the target at other 34 stations, with 1cm increment. The frequency of the transducers is 5 MHz. A 0.5 mm thick anvil of WC is placed between the impact source and the target surface to prevent microcraters formation. The travel time is determined by the first arrivaltime interval between the two signals assuming straight ray paths.

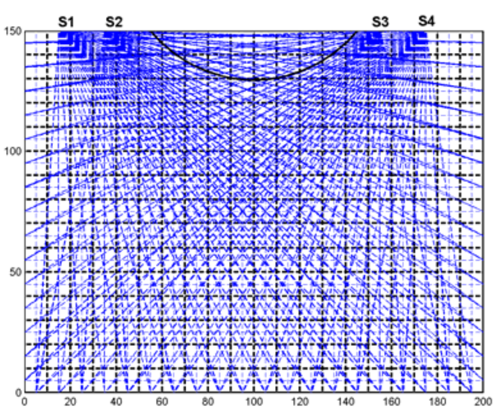

Figure 1: Tomographic ray diagram for 15x20 cm granite block. The black line is crater contour (not to scale).

Results and Discussion: Assuming the damage is symmetric, and the mechanic impact of WC ball is repeatable for each shot, a damped least square (DLS) method is used to invert the compressional wave velocity structure of the recovered target [4]. Fig. 2 is the result of the P-wave velocity structure of the recovered rock. The damage depth is ~ 7 cm for this shot. This is consistent with the result when cutting the the target open and measuring directly.

Tomographic method provides a suitable way to study the damage structure beneath laboratory and potential field craters.

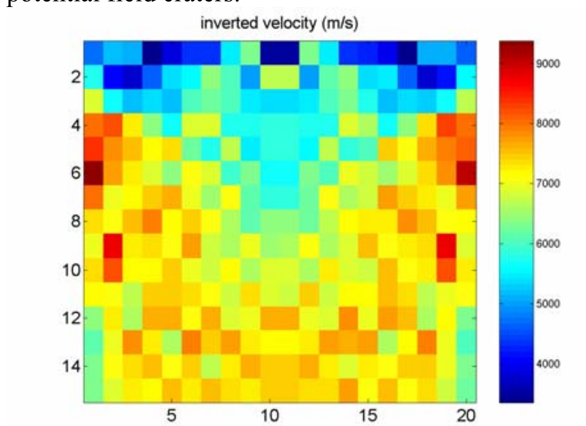

Figure 2: Results of the P-wave velocity structure in 15x20 cm block of San Marcos granite.

Further work: The assumption of straight ray paths for velocity inversion is a useful, first approximation. For the material with large velocity contrast, nonlinearity should be considered and iteration of ray tracing is necessary to get an improved velocity profile [4]. An inversion method that take into account ray curvature is presently being developed.

References:

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