SHOCKED MATERIALS FROM THE DUTCH PEAK DIAMICTITE, UTAH; F. Hörz[1], T.E. Bunch[2], and V.R. Oberbeck[2], [1]NASA Johnson Space Center, Houston, TX. 77058, [2]NASA Ames Research Center, Moffett Field, CA 94035,

INTRODUCTION: Comparative planetology established that large-scale impact bombardment affected the crustal evolution of planets, including Earth. It is also established that the Earth-Moon system suffered an early period of intense bombardment, yet impact events producing the Sudbury and Vredefordt craters, or the events at the KT boundary demonstrate that "large" scale impacts did occur throughout Earth history, which is also consistent with modern astronomical observations about the flux of Earth-crossing asteroids [1,2]. These considerations lead to the search for evidence of impacts in the early terrestrial record and we suggested that some of the highly polymict, clastic deposits previously mapped as glacial tillites or diamictites may indeed be the continuous ejecta deposits of large-scale impacts [3]. Evidence of shock-metamorphism in such a deposit would provide a powerful argument for their association with impact processes, because impact is the only geologic process capable of producing the prerequisite shock waves. We report here the first evidence of shock metamorphism in the Dutch Peak diamictite, S-Utah.

THE DUTCH PEAK FORMATION: The Dutch Peak diamictite in the Sheeprock Mountains, Utah, is of Proterozoic age and a minor part of the Dutch Peak Formation [4]. The diamictite occurs at the base of a sequence of geosynclinal sediments that rest on continental, crustal rocks; these sediments formed in response to a late Precambrian continental breakup event [5]. This structural setting is similar to that for other diamictites at continental breakup margins where they formed as some of the first sediments in the geosyncline and frequently interfinger with, or directly underlie basalts [5].

One of us (T.B.) collected specimen A250, a shocked sample, during a brief visit of the Harker Canyon area of the Sheeprock Mts, Utah. Some 62 granitic and quartzite samples were collected as pebble- or cobble-sized inclusions from float that was obviously from local sources. Of the many inclusions observed, only A250 appeared to be weathered and/or deuterically altered. It is the only shocked sample in the current collection. However, a few quartz grains in the clastic matrix of other thin sections from this diamictite reveal some basal deformation lamellae that may or may not be shock produced.

SHOCKED SAMPLE A250: This sample consists of equant, anhedral grains of quartz, K-feldspar and plagioclase, the latter heavily altered and weathered (*i.e.*, only few remnants of actual fedspar remain). The dominant quartz seems heavily recrystallized and annealed; undulatory extinction is rare, yet individual quartz grains are typically made up of a few ($n < 10$) discrete, slightly misoriented domains that have exceptionally sharp and crisp boundaries. Minor accessory minerals include chlorite, Mn-rich ilmenite, sphene and carbonate. Shock-produced planar elements in quartz are illustrated in Figure 1. They are all of the decorated type, their typical appearance in highly annealed hosts [6]. Most quartz grains contain at least 1 set of lamellae; 2 or 3 lamellae systems are common with 4 sets being the maximum number of sets observed in individual grains. Evidence for shock is thus pervasive in this specific sample. Figure 1 was taken with partially crossed polarizers, and illustrates the annealed domains alluded to above. These domains do not seem unusual or important per se, but they very much affect the precision

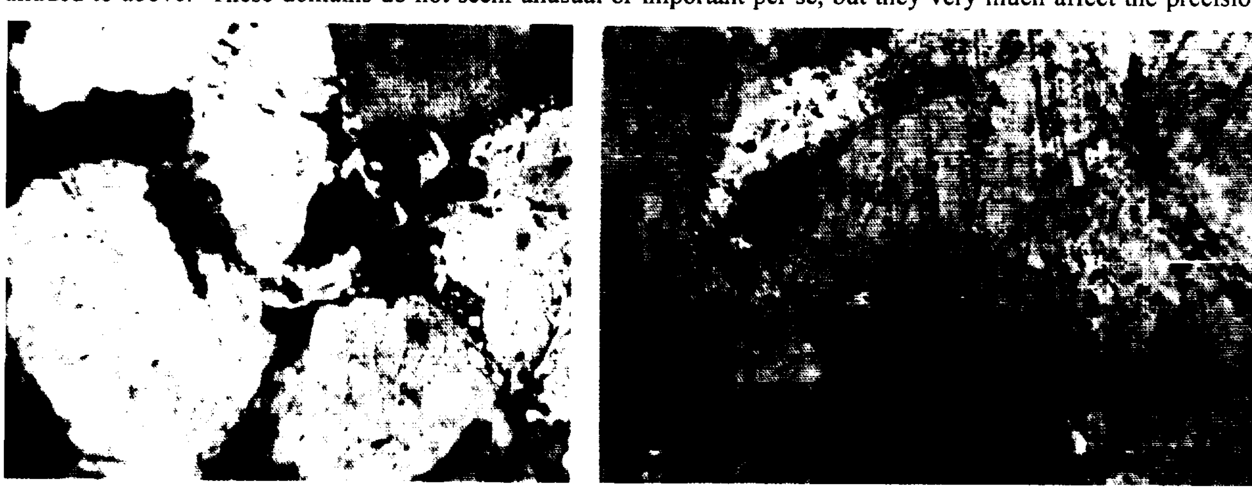

Figure 1. Overview of A250 (left; FOV = 2.5 mm) and multiple sets of shock lamellae (right; FOV = 0.3 mm).

with which the optical axis may be identified and measured, which in turn feeds into the accuracy with which the crystallographic orientation(s) of individual lamellae systems may be determined with optical (U-stage) methods. Obviously, this accuracy was not very good for sample A250.

Nevertheless, we measured the crystallographic orientation of 244 lamellae systems in 106 grains. Figure 2 illustrates the angle of the planar element normal to the optical axis for all measurements. Two broad maxima occur around 0 degrees (basal plane;{0001}) and around 22°, which coincides with the {10$\bar{1}$3} rational lattice plane of quartz. The stereographic projections (Figure 3) of select data demonstrate that {10$\bar{1}$2} orientations are present as well, although the latter orientation is not very prominent in Figure 2. The imprecision with which the optical axis could be measured in these samples leads to a relatively broad maximum between≅20° and 34° in Figure 2. Figure 3a is a stereoplot of the crystallographic orientation of 28 grains, each containing 3 sets of lamellae, while 3b summarizes 10 grains, each containing 4 lamellae sets. Note that some 75% of all systems follow rational lattice planes. These observations and crystallographically controlled deformations are consistent with shock [6,7,8].

CONCLUSION: We report on the first evidence of shock processes in materials associated with diamictite. It is presently difficult to evaluate the significance of this single specimen. Without additional and substantial field-work, and petrographic characterization of this formation, a number of scenarios for the presence of a shocked clast and the emplacement of the entire formation remain viable.

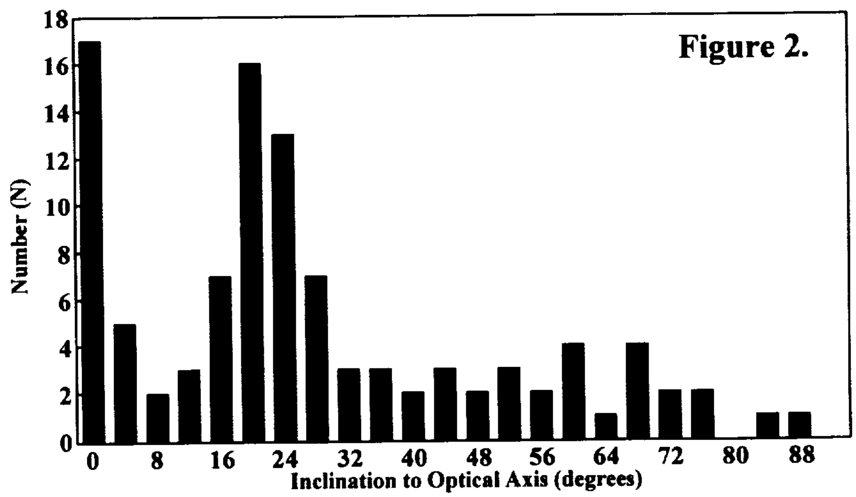

Figure 2.

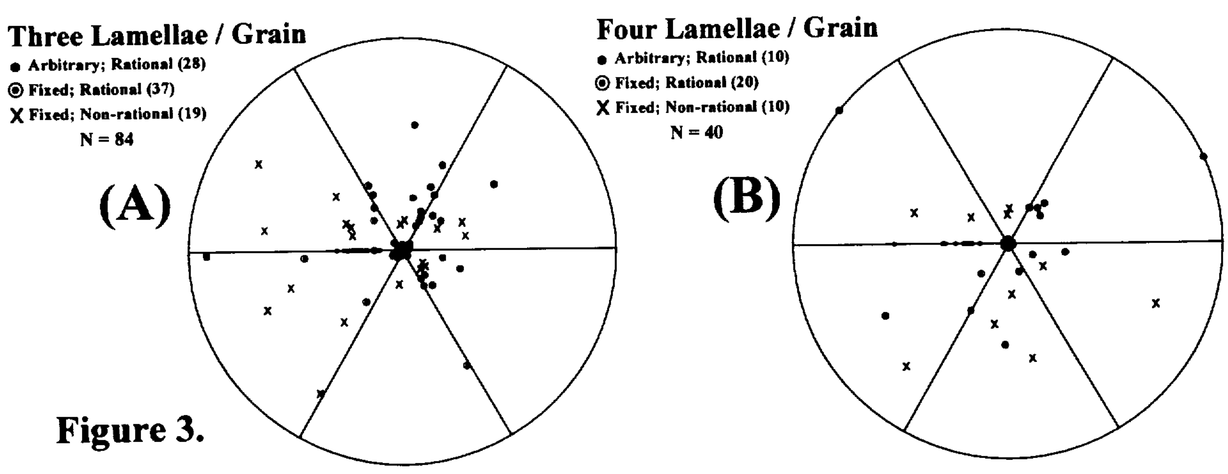

Figure 3.

REFERENCES: [1] Wetherill, G. W. and Shoemaker, E.M.(1981)*Geol. Soc. Am. Spec. Pap. 190*, 1-14; [2] Grieve, R.A.F. and Pesonen L.J. (1992), *Tectonophysics, 216*, 1-30; [3] Oberbeck , V.R.*et al.* (1993), *J. Geology, 101*, 1-19; [4] Blick, N. (1981), *Earth's Pre-Pleistocene Glacial Record*, Cambridge University Press, London, p.740-744; [5] Stewart. J.H. (1972), *Geol. Soc. Amer., 83*, 1345-1360; [6] Engelhardt, W.v.*et al.* (1968), in *Shock Metamorphism of Natural Materials*, Mono Book Baltimore, p. 475-482; [7] Hörz, F. (1968), in*Shock Metamorphism of Natural Materials*, Mono Book, Baltimore, p. 243-254; [8] Alexopoulos, J.S. *et al.* (1988), *Geology, 16*, 796-799.