PRELIMINARY PETROLOGIC ANALYSIS OF IMPACT DEFORMATION IN THE CARANCAS (PERU) CRATERING EVENT. R. S. Harris[1], P. H. Schultz[1], G. Tancredi[2], and J. Ishitsuka[3], [1]Department of Geological Sciences, Brown University, Providence, RI 02912 (Scott_Harris@brown.edu), [2]Departmento Astronomíca, Facultad de Ciencias, Iguá 4225, 11400 Montevideo, Uruguay, [3]Instituto Geofisico del Perú, Calle Badajoz #169, Mayorazgo IV Etapa, Ate Vitarte, Lima, Peru.

Introduction: On September 15, 2007, an ordinary chondrite (H4/5) at least 1 meter across struck the Altiplano of southeastern Peru [1-4]. The collision excavated a circular crater approximately 15 meters wide a few meters deep into channel and bank deposits of a narrow arroyo (Fig. 1). The Carancas crater and its ejecta field provide a unique opportunity to investigate fresh microscopic and mesoscale deformation produced by a hypervelocity impact into well-constrained clastic detritus and regolith. Our observations will be compared to large-scale and experimental impacts in order to constrain the dynamic parameters of the Carancas event and to better understand sedimentary target impacts in general.

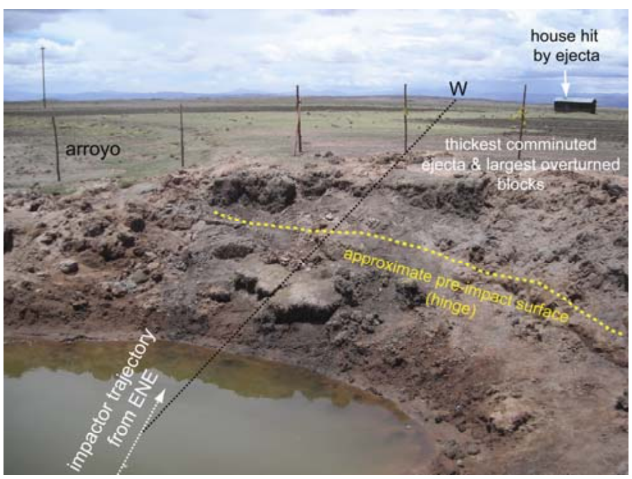

Figure 1. Photograph of the Carancas crater centered on the western wall. E-W line (black) is shown for reference. The impactor struck from the ENE (Az≈80º) [2]. The largest spallation blocks and thickest accumulations of finely comminuted ejecta (approximately 50 cm thick) are located behind the WNW to NW rim.

Field Observations: Ejecta blocks ranging from 10s of centimeters to approximately one meter across are observed extending several meters from the rim around most of the crater, although possible zones of avoidance may be present to the N and ESE. Blocks derived from beneath the arroyo, clustered outside the S to SE rim, are observed in a variety of orientations from top-up to completely overturned. These may not represent the original orientations, however, as that side of the crater apparently has been disturbed.

Beyond the WNW to NW rim the largest blocks are overturned and resting in a blanket of extremely fine, powdery material up to approximately 50 cm thick. The exposed "underbellies" of some of these blocks are riddled with embedded, weathered fragments of the impactor (Fig. 2A, B). Fragments can be seen on the upper surfaces and also dug from several centimeters deep inside the blocks. Some fragments of similar target material ejected farther from the crater also contain small embedded pierces of the bolide (Fig. 2C, D). In spots, the impactor is disseminated in the target materials at the grain scale.

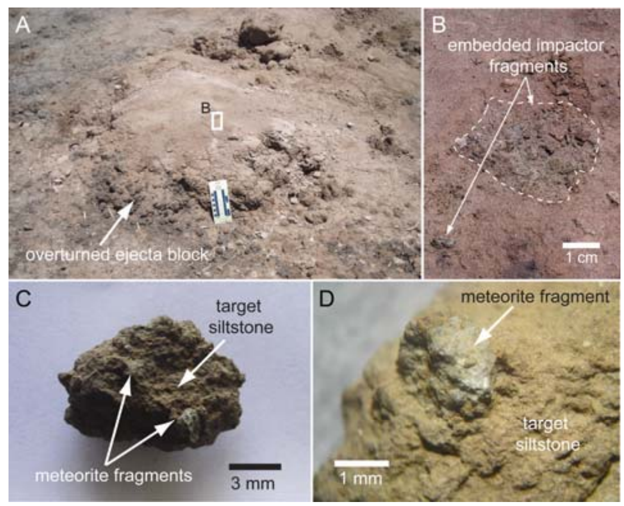

Figure 2. Embedded impactor parts. A, B) Photographs of a large overturned ejecta block outside the NW rim of the Carancas crater. The dark, organic-rich A soil horizon is crushed beneath the B horizon, composed of caliche and carbonate-cemented silty sediments. The block is riddled with meteorite fragments ranging from millimeters to several centimeters wide. C, D) Photograph and close-up of a smaller ejected piece of siltstone that also contains finely disseminated fragments of the bolide.

The implantation or injection of impactor fragments into strata that were derived from beneath the pre-impact surface supports the hypothesis that the bolide was competent and largely intact when it struck the ground. The impactor likely fragmented and dispersed a few decimeters beneath the surface just ahead of the affected sediments peeling back and being thrown from the crater.

Subsequently, these blocks have been exposed to rainwater and strong winds. The fine carbonate-cemented silts and clays, along with corroded metal and metal oxides in impactor fragments, are being washed and winnowed from the surface. The result is that a thin pediment of meteoritic silicates (olivine, pyroxene, etc.) is developing atop the proximal ejecta. This observation may have important implications for considering the composition of ejecta and regoliths on Mars and the Moon (see [3]).

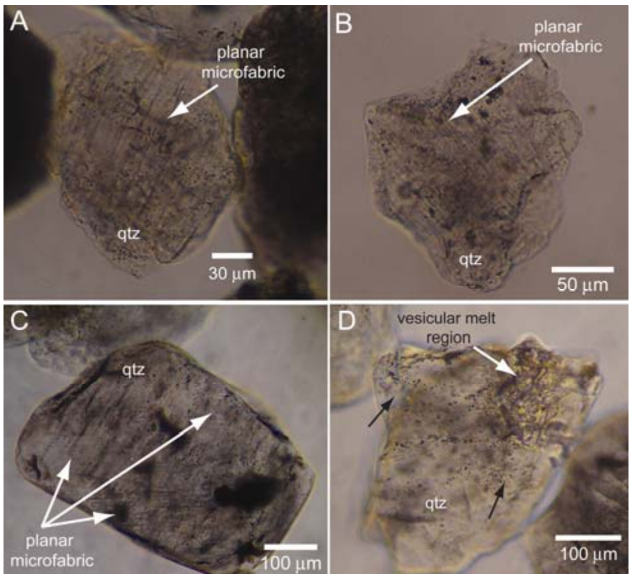

Figure 3. Weakly shocked quartz grains. A, B) Photomicrographs (PPL) of a quartz grain exhibiting basal planar microfabrics. Similar grains are abundant in fine, pulverized ejecta collected from the NW rim. C) Photomicrograph (PPL) of a quartz grain collected from beneath a large meteorite fragment embedded in target material. D) Photomicrograph (PPL) of a quartz grain from comminuted ejecta on the NW rim that appears to have melted at one end. The grain also contains very faint planar microfabrics (black arrows).

Microscopic Observations: Preliminary examination of ejected sediments and blocks from the Carancas crater have revealed little to no evidence of melting. Tiny (<200μm) glassy fragments are observed in some sediments but these are very rare and as yet indistinguishable from volcanic shards that would be expected in this setting. Some melt-like bodies have been found in close proximity to impactor fragments (Fig. 4B), but these likely are composed of agglutinated meteoritic ablation debris. There probably was not significant heating of the target associated with this impact.

Mineral grains with tentatively identifiable shock-induced microfabrics are observed in both proximal and distal ejecta samples but typically account for only one or two grains per thousand. The notable exception is the finely comminuted ejecta outside the NW rim. Better than one in 30 quartz grains exhibit planar microfabrics (Fig. 3A-C) very similar to those produced by experimental impacts into loosely consolidated sediment at velocities ~4 to 6 km/s (e.g., [5]). The majority of fabrics appear to be single sets of basal lamellae (possibly basal Brazil twin planes) although a few grains may contain more than one set of planar elements. Orientation data is forthcoming. A few grains show evidence of melting at grain boundaries (Fig. 3D), which also has been observed in laboratory experiments [5]. And some plagioclase feldspar grains exhibit features that may be true planar deformation features (PDFs) (Fig. 4A).

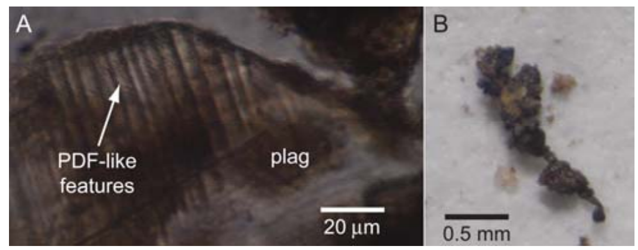

Figure 4. A) Photomicrograph (PPL) of a plagioclase grain exhibiting short, *en echelon* structures similar to planar deformation features (PDFs) observed in feldspars shocked ≥ 10 GPa [e.g., 6]. B) Photograph of a tiny melt particle collected from beneath a meteorite fragment embedded in target ejecta.

Conclusions: Our preliminary analyses of material deformation at the Carancas impact crater support the hypothesis that the event involved a fully coupled collision of a largely intact bolide with the surface. The impact velocity of 3 km/s estimated by [2] is probably a lower limit and could be as high as 4 to 6 km/s based on comparisons to experiments.

References: [1] Macharé J. et al. (2007) La Caida del Meteorito Carancas (Informe inicial oficial de INGEMMET),www.ingemmet.gob.pe/paginas/07_09_21_Carancas_meteorite.pdf. [2] Tancredi G. et al. (2008) *LPS XXXIX*, this meeting. [3] Schultz P. H. et al. (2008) *LPS XXXIX*, this meeting. [4] Brown P. et al. (2008) *Earth Planet. Sci. Lett.*, submitted. [5] Stöffler D. et al. (1975) *JGR, 80*, 4062–4077. [6] French B. M. (1998) Traces of Catastrophe; LPI, Houston, 120 pp.

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