**LA DULCE CRATER: EVIDENCE FOR A 2.8 KM IMPACT STRUCTURE IN THE EASTERN PAMPAS OF ARGENTINA.** R. S. Harris[1], P. H. Schultz[1], and M. A. Zárate[2], [1]Department of Geological Sciences, Brown University, Providence, RI 02912 (Scott_Harris@brown.edu), [2]Facultad de Ciencias Exactas y Naturales, Universidad Nacional de La Pampa, Avda Uruguay 151, 6300 Santa Rosa, La Pampa, Argentina.

**La Dulce Impact Crater :** Melt breccias formed by seven different hypervelocity impacts have been identified in the upper Miocene to Holocene stratigraphy of the Argentine Pampas [1-4]. Glasses from two mid-Pleistocene events, 230 ka and 445 ka, occur in strata exposed along the Atlantic shoreline between Necochea and Centinela del Mar [3]. Examination of remote sensing data for this region of Argentina led us to investigate a conspicuous circular structure (Fig. 1) approximately 2.8 km in diameter near the village of La Dulce as a possible source crater for either of these deposits.

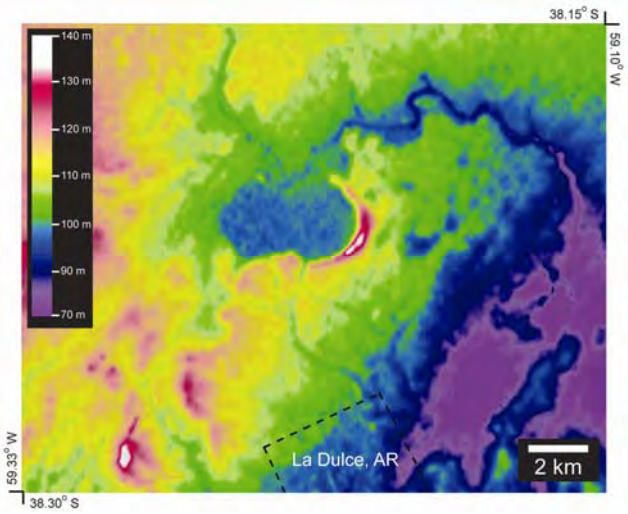


**Figure 1.** Relief map showing the La Dulce impact structure and vicinity. Topography from the Shuttle Radar Topography Mission (SRTM) dataset.

Analyses of finely laminated marly rocks, which we collected from hummocky deposits on the flanks of the crater rim (Fig. 2), found that they contain:

- carbonate accretionary lapilli (Fig. 3A);
- carbonate spherules;
- fragments of altered impact melt breccias;
- shock-deformed minerals including quartz, plagioclase, and ilmenite (Fig. 3B);
- exquisite particles of lechatelierite (Fig. 3C).

The evidence suggests that these rocks are ejecta from a hypervelocity impact and support the conclusion that the La Dulce structure is an impact crater. The crater most likely formed during a bolide collision with the Rio Quequén 445 ka. Because the target was composed largely of the thick loess and loessoid sediments that blanket the Pampas, the La Dulce structure may provide important insights into crater formation in fine, loosely consolidated, volcanic-derived sediments. Consequently, it also may provide a useful analog for impact processes in the Martian regolith.

**Figure 2.** Photograph showing an outcrop of finely laminated, sandy, carbonate-rich rock exposed on the flanks of the La Dulce structure. The rock contains abundant carbonate accretionary lapilli along with molten and shock metamorphosed minerals indicative of a hypervelocity impact.

**Crater Morphology and Geophysics:** A steep cliff-lined rim walls the La Dulce crater on its eastern and southern sides. There the rim rises from 25 to more than 40 meters above the interior floor and 10 to 20 meters above the exterior plain. Radar data show that the northern rim is a much-subdued, but nonetheless complete, arcuate structure. It likely has been modified by the Rio Quequén which appears to have been diverted eastward by the formation of the crater and emplacement of its ejecta to the northeast

A narrow section of the western rim is missing, and the crater appears to neck into a quasi-circular depression with a diameter comparable to the La Dulce crater. This western depression is bound on the south by a wall 10 to 20 meters high. The remainder is outlined by much lower relief except for a short, high-standing cliff along its northern arc. It is possible that this western structure represents a double impact. Although this hypothesis is plausible and presently cannot be discarded, we are investigating what role post-impact modification by the Rio Quequén alone could have played in generating this companion.

Available gravity data suggest that the La Dulce structure is associated with a negative gravity anomaly approaching 1 milligal. The anomaly is approximately centered on and is of similar dimensions to the primary crater.

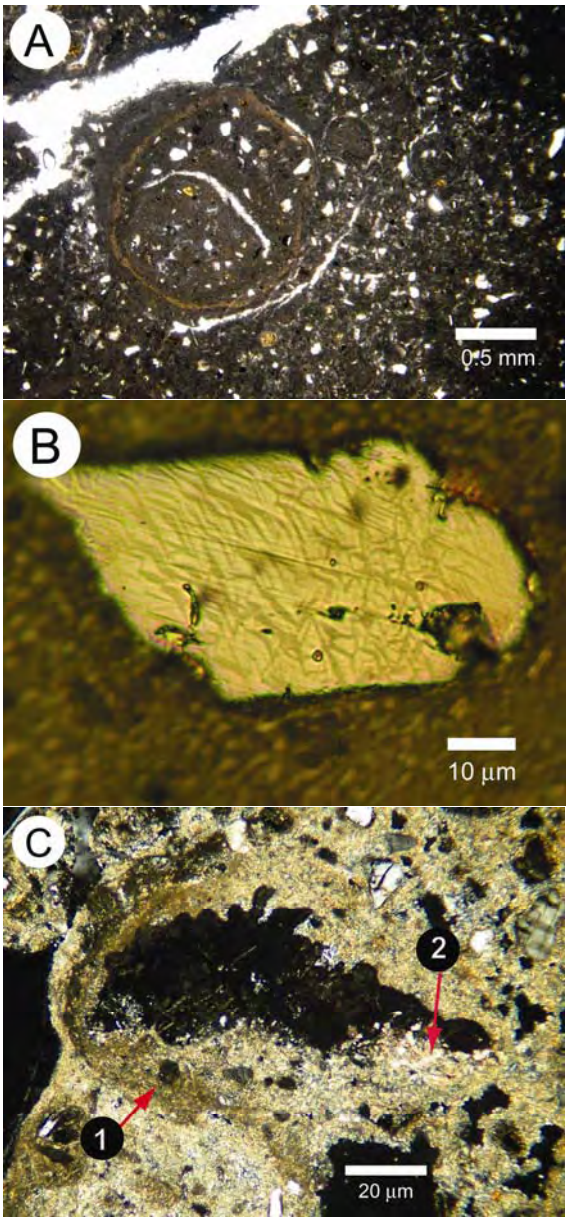


**Figure 3.** La Dulce ejecta. A) PPL photomicrograph showing several carbonate accretionary lapilli similar to those found in the Alamo Breccia and Chicxulub deposits [5,6]. B) Reflected polarized-light photomicrograph of an ilmenite grain containing multiple sets of faulted and sigmoidally bent microtwins characteristic of shock [7-9]. C) XPL photomicrograph showing a particle of fused silica, or lechatelierite, exhibiting fluidal and aerodynamic morphologies. The lechatelierite is encased in a lapilli-like rind of carbonate. A smaller lechatelierite spherule is attached at (1). SEM observations at (2) suggest that the bright material there was molten carbonate.

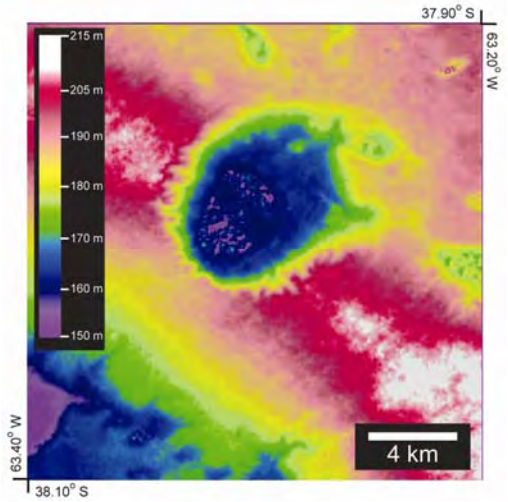


**Figure 4.** SRTM relief map showing the General San Martin structure in western Buenos Aires Province.

**Another Possible Pleistocene Crater:** We also are investigating a second possible Pleistocene impact structure near the town of General San Martin close to the boundary between Buenos Aires and La Pampa Provinces. Although unimpressive in satellite photography, the structure is unambiguous in radar (Fig. 4). Its relief is a significant regional anomaly. Aerial reconnaissance confirms that the rim creates a broad topographic rise distinct from the numerous other lakes and salt pans in the area. It is 10 to 12 km in diameter, and its floor lies at least 55 meters below the rim. Ground observations show that the rim is composed of highly fractured carbonate-cemented loess in places covered by carbonate breccias similar to some of the deposits surrounding La Dulce. Presently, direct evidence for an impact origin is lacking. However, we have sampled a glassy mass unearthed only a few kilometers from the structure which is very similar to tagamitic bombs found near the rims of known impact craters. This impact melt gives a tentative $^{40}Ar/^{39}Ar$ age of approximately 1.2 Ma.

**References:** [1] Schultz P. H. et al. (1994) *Geology, 22,* 889-892. [2] Schultz P. H. et al. (1998) *Science, 282,* 2061-2063. [3] Schultz P. H. et al. (2004) *Earth Planet. Sci. Lett., 219,* 221-238. [4] Schultz P. H. et al. (2006) *Meteor. Planet. Sci,. 41,* 749-771. [5] Warme J. E. et al. (2002) *Geol. Soc. Am. Spec. Paper 356*, 489-504. [6] Pope et al. (2005) *Geol. Soc. Am. Spec. Paper 384*, 171-190. [7] Minkin J. A. and Chao E. C. T. (1971) *Proc. LSC 2nd*, 237-246. [8] Sclar C. B. et al. (1973) *Proc. LSC 4th*, 841-859. [9] El Goresy A. et al. (2001*) Am. Min., 86,* 611-621.

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