# THE CARANCAS CRATER AND METEORITE FALL: THE FIRST RECORDED IMPACT ON EARTH

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**Introduction:** On September, 15th, 2007, close to noon local time, a bright fireball was observed and heard in the southern shore of the Lake Titicaca, close to the border between Peru and Bolivia. Many peasants and residents of several towns observed the fireball from East to West. The peasants of the Community of Carancas, that were watching out their llamas and alpacas, heard a big explosion and observed the formation of a mushroom cloud. Minutes after they found a ~15m hole in the terrain, half filled by underground water, and a lot of dispersed blocks of soils of sizes over a meter. Some pieces of a grayish material were found, clearly distinct from the sedimentary rocks of the terrain. The walls of the crater showed a gray powder spread everywhere. In a preliminary analysis to the collected material, we found the presence of chondrules in the grayish material and we observed that the dispersed blocks showed an ejecta pattern. It is the first time in the recorded history that several persons witness the formation of an impact crater. An international and multidisciplinary group was created to study this interesting event.

**The fireball and its trajectory:** Both infrasound as well as seismic stations detects the airblast in the upper atmosphere and the explosion when the meteorite strokes the earth. The closest stations to the impact site, detected the P and S seismic waves generated due to the impact; it is the first time that a direct impact on Earth is recorded by a seismic station. Brown et al. [1] and Le Pichon et al. [2] obtain a trajectory solution using the infrasound and seismic data; they place the fireball radiant at an azimuth between 80-110° relative to the crater with an entry angle from the horizontal of 45-65°, a pre-atmospheric velocitiy $v \leq 18$ km/s and an impact time of 16h40m17s UT. These solutions are compatible with NEAs' orbits with low inclinations.

**The meteorites:** Petrographic and EMP analysis were performed in two thin sections of samples of collected material. The chondrule textures, the minor amount of clinopyroxene as well as the relatively uniform composition of olivine and pyroxene grains (Fs:16.7, Fa:18) allows classification of Carancas as an H 4-5 Ordinary Chondrite.

Fig. 1 – Photo of the crater and the close ejecta.

**The crater:** In Fig. 1 we present a photo of the crater. The crater was formed in the bank of an ephemeral river channel. It partly occupies the riverside and the dry bed. The shape of the crater and the distribution of ejecta corresponds to an impact crater rather than a penetration hole. Pieces of brown soil ejecta were found at distance over 350m from the crater in the SW direction, in correspondence with the ~EW direction of the trajectory. No pieces of the meteorite larger than a few kg were found yet. The meteorite was strongly decelerated in the passage through the atmosphere. Nevertheless, the impact velocity was ~>3 km/s [3]. Using cratering laws [4], we obtain that the impactor should have a diameter of ~1 m, a mass of ~2 tons and the impacting energy was ~3 ton TNT.

**Discussion:** Unlike what it is generally expected, a few tons stony meteorite did not disintegrate in its passage thorugh the atmosphere, but rather it reached the ground with a velocity high enough to produce an impact crater. This event challenge our present view of the fate of meteoroids striking the Earth. The presence of small craters on Earth as well as Mars has to be reanalyzed on the basis of the Carancas event.

**References:** [1] P. Brown et al. (2008) accepted JGR-Planets. [2] A. Le Pichon et al . (2008), accepted in Meteoritics and Planetary Science. [3] , R. S Harris et al. (2008) LPSC XXXIX, LPI Contribution No. 1391, p. 2446 [4] K. Housen, K. Holsapple (2007) *Icarus*, 187, 345-356.