Revisiting the Campo del Cielo, Argentina crater field: A new data point from a natural laboratory of multiple low velocity, oblique impacts

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Introduction: The energy of formation of very low angle impact craters in loess targets is not well-known. The Campo del Cielo, Argentina crater field (CdCcf) represents a natural laboratory of at least 22 low-angle impact craters formed in loess ~4000 years ago. Because of the uniformity of the loess and composition of the projectiles, as well as a limited range of impact velocities, calculation of energies of crater formation are simplified. Remaining variables are the masses of the impacting projectiles and the azimuths and angles of impact. Therefore, the CDCcf is an excellent location to obtain field data and relate these data to the impact process. Early work focused on the discovery and magnetic surveys of various craters in the CdCcf [1,2], but only 2 craters were excavated (1 in detail). Research to be carried out under the current grant will focus on examining more craters in the CdCcf and using theoretical modeling and hypervelocity impact experiments to understand the crater formation process. Here, we report on the results of the first year of current research. Two more possible craters were located in addition to 20 previously reported [1]. Extensive magnetic gradiometer and ground-penetrating radar (GPR) data were collected at two previously known sites (Craters 13 & 16). Crater 13 was trenched in three places and the meteorite that formed it was recovered. Data on Crater 13 follow.

Crater 13 magnetic gradient map: Figure 1 displays magnetic anomalies outlined using an Institut Dr. Foerster magnetic gradiometer. Gradients over a vertical interval of 60 cm were measured at ground level. Negative lobes appear deeper than positive ones. There is a positive/negative pair over the point where the meteorite was discovered, but the negative lobe is much closer to the location of the meteorite than is the positive one. This effect may be dictated by the relative strength of the negative lobe. Positive/negative pairs occur in other places in the crater where meteorites are not located. They parallel the apparent long axis of the crater; *i.e.*, the apparent azimuth of impact and consequent penetration path of the meteorite (compare Figures 1 & 2). We do not understand the cause of this effect, but speculate that there may be very finely divided NiFe grains liberally mixed into the infilling soil. Again, the stronger negative lobes are located closer to the entry path of the meteorite, which has been extrapolated from the structure of the crater.

Crater 13 structure immediately after impact: The structure of the original, pre-erosion crater is shown as Figure 2. Trenching revealed a lens of granular chunks of reddish clay that was assumed to outline deeper levels within the original crater. In this respect Crater 13 was similar to Crater 10 No structure was detected for about seven meters in front of the point where the Crater 13 meteorite eventually came to rest. This seems to be analogous to the situation at Crater 10, where the crater structure disappeared about 17 meters before the point where its meteorite came to rest.

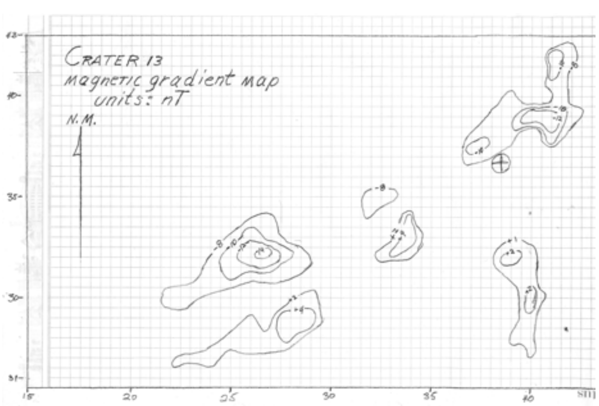

Figure 1. Magnetic gradient map of Crater 13. Units are in nanoTeslas (nT). † indicates the position of the meteorite.

Figure 2. Structural map of Crater 13. Depths are in meters below the surrounding surface. † indicates the position of the meteorite.