A POSSIBLE IMPACT STRUCTURE IN AMAZONIAN BOLIVIA, K.E. Campbell, Natural History Museum of Los Angeles, Los Angeles, CA 90007, R.A.F. Grieve, Geophysics Division, GSC, Ottawa, K1A 0Y3, J. Pacheco Z., Servicio Geologico de Bolivia, La Paz, Bolivia, and J.B. Garvin, Code 622, NASA-GSFC, Greenbelt, MD 20771.

We report here the discovery of a new possible impact structure in Amazonian Bolivia. The crater, discovered and to date analyzed primarily through satellite imagery and aerial photographs, is located at the southern limit of the Amazonian forest, where it gives way to the grasslands of the Bolivian Pampas. It is centered at approximately 12°35'S, 67°38'W, at an elevation of 180-190 m, in Provincia Abel Iturralde, Departamento de La Paz.

The pampas of eastern Bolivia are maintained by long-term, seasonal flooding. Vegetation in and surrounding the pampas is very sensitive to flooding. As a consequence, very minor changes in relief are directly reflected in vegetation type, with high canopy forest growing in the relatively higher relief areas and only grass in the lower areas. Maximum relief near the structure does not exceed 10 m but this is sufficient to allow a fairly clear interpretation of the structure and internal relief by an analysis of the vegetation types within and around it. As can be seen by examination of the processed LANDSAT TM image (Fig. 1), the circular structure, 8 km in diameter, is characterized by a slightly elevated, scalloped rim with minor radial drainage and a shallow interior. The interior contains a narrow, lunate area to the NNW that appears to be its deepest part, an irregular, raised area roughly 2 km in diameter, off-center to the SSW, from which several narrow, comparably elevated, strips of land radiate to the rim and in the center of which lies a 1 km diameter circle of yet higher ground.

An excellent circumstatial case can be made for an impact origin for the structure. (i) The Amazonian Basin is a large intracratonic sedimentary basin. In this area, the depth to basement is estimated at 3 km (1). The structure is, therefore, unlikely to reflect basement structure. (ii) It is unique to the area, which is virtually devoid of geologic expression beyond that of Tertiary and Quaternary sedimentation and fluvial erosive activity. The structure is clearly superimposed upon the local relief. (iii) It is over 500 km from the nearest known volcanic or karst terranes. (iv) The general form of the structure: elevated rim, annular trough and central uplift is that of a complex impact structure.

The structure is in alluvial deposits that accumulated during the late Pleistocene in a vast finger delta over SW Amazonia, at a time when the region was covered by a great, shallow, fresh-water lake. The structure is on the leading edge of the delta, severing one of its fingers (Fig. 2). The alluvial deposits comprise three horizons, up to 45 m thick in Bolivia, of fine sands, silts, and clays that overlie Tertiary (late Miocene) deposits (2). The basal horizon of the late Pleistocene deposits contains fossil tree trunks, three of which yielded radio-carbon ages ranging from 32,780 ± 450 to 36,520 ± 950 years B.P. Deposition in the region ceased about 11,000 years B.P. (2). The lack of any clear infilling of the structure suggests that impact occurred very near or after the cessation of deposition. The lack of great depth to the structure and the presence of the noted internal features may be the result of the combination of unconsolidated alluvial deposits and abundance of water at the time of impact. A structure of this diameter in a consolidated sedimentary target is expected to have a depth of ~200 m (3). In this case, the impacted target likely behaved as low strength material throughout the entire cratering process, reducing final topographic expression (4).

This structure, named the Iturralde Structure, may represent a unique opportunity. Its likely age of ~30,000-10,000 years B.P. would make it the youngest known complex impact structure on earth. The structure represents an opportunity to directly study natural impact into low strength materials. Although it appears to have a general complex form, detailed studies may provide important information for analog studies with Martian impact structures formed in volatile-rich terranes and previous experimental explosion craters in alluvium (5). The nature of the target may also have led to the formation of unusual shock metamorphic effects compared to those in crystalline and consolidated sedimentary targets. Although very young, there is no obvious expression of ejecta. This is not entirely unexpected in an area that is subjected to annual flooding.

The Iturralde Structure is located ~250 km from the closest center with commercial air service in an area with essentially no roads. A relatively low-cost expedition travelling by river and foot, which included the first three authors and was funded by the National Geographic Society, just failed to reach the structure during the 1987 dry season. A critical, but somewhat unpredictable, aspect is timing, such that the low-lying pampas are dry but river levels have not fallen to the point of being unnavigable. A helicopter-supported expedition is probably required to be more successful.

REFERENCES (1) G. Plafker, B.G.S.A., 75, 503-522 (1964). (2) K. Campbell et al., Contrib. Sci., Nat. Hist. Mus. Los Angeles, No. 364, 18 p. (1985). (3) R. Grieve and P. Robertson, Icarus, 38, 212-229 (1979). (4) R. Greeley et al., PLPSC 11th, 2075-2097 (1980). (5) G. Jones, Impact and Explosion Cratering, 163-168 (1976).

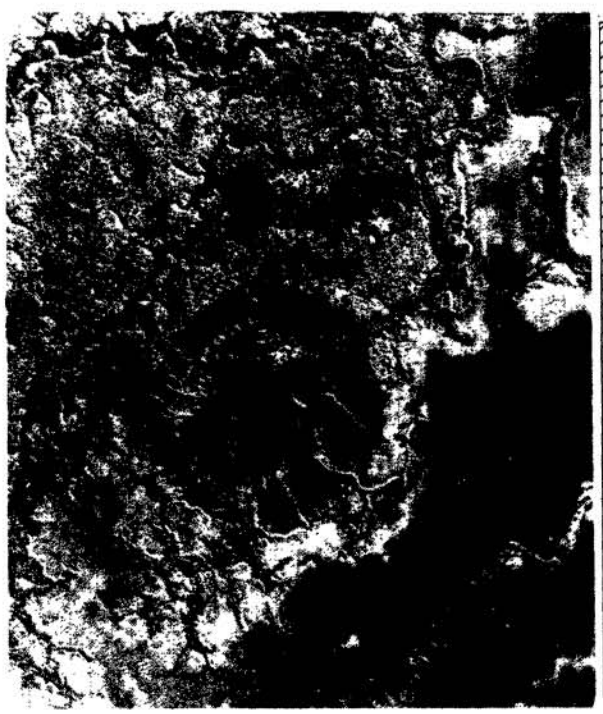

Fig. 1. Second principal component LANDSAT TM bands 1,4,5,7, image of Iturralde Structure.

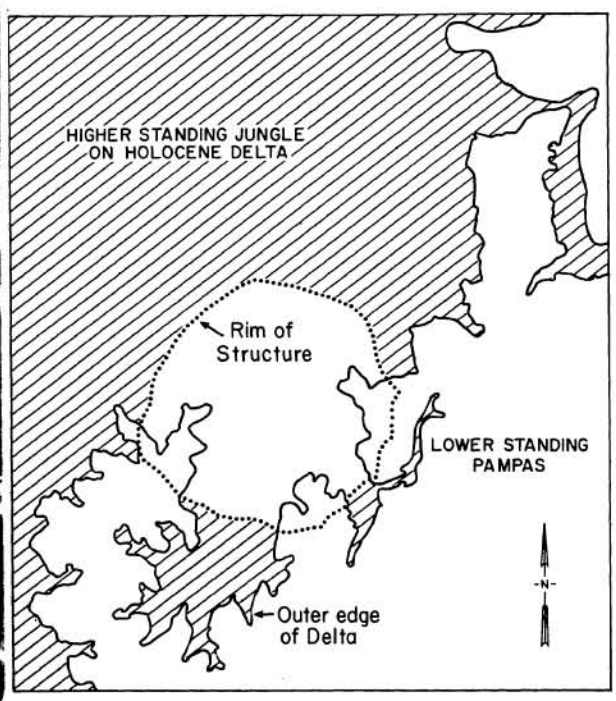

Fig. 2. Line drawing of Fig. 1 showing imposition of structure on delta finger.