Available online at www.sciencedirect.com
ScienceDirect
C. R. Geoscience 340 (2008) 801–810
COMPTES RENDUS GEOSCIENCE
http://france.elsevier.com/direct/CRAS2A/

Geomaterials

Impact ejecta and carbonate sequence in the eastern sector of the Chicxulub crater

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Received 12 July 2007; accepted after revision 25 August 2008
Available online 1 November 2008

Presented by Claude Jaupart

Abstract

The Chicxulub 200 km diameter crater located in the Yucatan platform of the Gulf of Mexico formed 65 Myr ago and has since been covered by Tertiary post-impact carbonates. The sediment cover and absence of significant volcanic and tectonic activity in the carbonate platform have protected the crater from erosion and deformation, making Chicxulub the only large multi-ring crater in which ejecta is well preserved. Ejecta deposits have been studied by drilling/coring in the southern crater sector and at outcrops in Belize, Quintana Roo and Campeche; little information is available from other sectors. Here, we report on the drilling/coring of a section of ∼34 m of carbonate breccias at 250 m depth in the Valladolid area (120 km away from crater center), which are interpreted as Chicxulub proximal ejecta deposits. The Valladolid breccias correlate with the carbonate breccias cored in the Peto and Tekax boreholes to the south and at similar radial distance. This constitutes the first report of breccias in the eastern sector close to the crater rim. Thickness of the Valladolid breccias is less than that at the other sites, which may indicate erosion of the ejecta deposits before reestablishment of carbonate deposition. The region east of the crater rim appears different from regions to the south and west, characterized by high density and scattered distribution of sinkholes. ***To cite this article: J. Urrutia-Fucugauchi et al., C. R. Geoscience 340 (2008).***

Résumé

Projections d'impact et séquence carbonatée dans le secteur oriental du cratère Chicxulub, Mexique. Le cratère de Chicxulub, de 20 km de diamètre, situé sur la plate-forme du Yucatan dans le Golfe du Mexique a été formé, il y a 65 Ma et a été recouvert depuis par des carbonates post-impact tertiaires. La couverture sédimentaire et l'absence d'activité tectonique et volcanique significative dans la plate-forme carbonatée a protégé le cratère de toute érosion ou déformation, faisant du Chicxulub le seul grand cratère à plusieurs anneaux, dans lequel les projections d'impact aient été conservées. Celles-ci ont été étudiées par forage et carottage dans le secteur sud du cratère et à l'affleurement à Belize, Quintana Roo et Campeche ; peu d'informations sont disponibles pour les autres secteurs. Dans cet article sont présentés les résultats du forage/carottage d'une section de 34 m de

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1631-0713/$ – see front matter
doi:10.1016/j.crte.2008.09.001

brèches calcaires à 250 m de profondeur dans la région de Valladolid (à 120 km du centre du cratère) ; celles-ci sont interprétées comme les dépôts proximaux des projections d'impact. Ces brèches calcaires se corrèlent avec celles qui ont été carottées dans les puits de Peto et de Tekax vers le sud, à une distance radiale similaire. Cela constitue la première occurrence. Comme dans le secteur est proche de la bordure du cratère. L'épaisseur des brèches de Valladolid est moindre que dans les autres sites, ce qui peut indiquer l'érosion des dépôts d'impact avant le dépôt des carbonates. Le secteur est de l'anneau du cratère apparaît différent des régions sud et ouest, caractérisées par une forte densité et une distribution dispersée de dolines. ***Pour citer cet article : J. Urrutia-Fucugauchi et al., C. R. Geoscience 340 (2008).***

Keywords: Impact ejecta; Sedimentary cover; Multi-ring crater; Chicxulub crater; Yucatan peninsular; Mexico

Mots clés : Projections d'impact ; Couverture sédimentaire ; Cratère à plusieurs anneaux ; Cratère de Chicxulub ; Yucatan ; Mexique

1. Introduction

The Chicxulub structure in the northwestern Yucatan peninsula (Fig. 1) is currently interpreted in terms of a large bolide impact that occurred 65 Myr ago at the Cretaceous/Tertiary (K/T) boundary [6,7,20,21]. The impact produced a large 200 km diameter crater, as well as significant structural deformation on the target area and adjacent carbonate platform. The Chicxulub impact has been linked to the worldwide-distributed iridium-rich clay layer that has been the stratigraphic marker of the K/T boundary. The K/T layer formed as a result of ballistic-emplaced material and deposition of fine-grained particle material sent out high into the atmosphere by the impact. The reentry of ballistic material and dust that blocked incoming solar radiation caused severe global environmental and climatic effects and disruption of life support systems [1,15].

The Chicxulub crater is located half offshore and half on-land in the Yucatan platform of the southern Gulf of Mexico, and is buried by a sequence of Tertiary carbonate rocks [6,16]. The carbonate sedimentary cover has partly protected the impact ejecta from erosion and weathering. There is interest in studying the reestablishment of carbonate deposition and erosive processes after crater formation from slumping, sea water back surge and rim collapse. Impact polymictic breccias have been drilled at four localities inside the crater and at two localities outside the crater rim in the southern sector [23]. Carbonate breccias have been drilled outside the crater rim at six localities [23]. The western and eastern sectors of the crater have been less studied, as compared to the offshore northern sector and the sector to the south. Study of those sectors is important for a number of factors, including target pre-impact structures, platform evolution and karsticity and possible asymmetries in crater morphology and ejecta distribution inside and outside crater rim. Gravity and magnetic anomalies show departures from the concentric semicircular pattern, suggesting asymmetry of crater geometry and melt and breccia deposits. Outside the crater rim in the eastern sector, the cenotes show higher density and scattered distribution as compared to the south [4,12,16,17].

In this paper, we report on the initial results of the study in the eastern on-land sector of the crater, in the area between Merida and Valladolid (Fig. 1) and discuss their implications for crater morphology, ejecta deposit distribution and post-impact carbonate sequence.

2. Chicxulub crater

The Chicxulub crater has an approximate center at Chicxulub Puerto on the present coastline (Fig. 1); it has been imaged by geophysical surveys including gravity, magnetics, magnetotellurics and seismic reflection and refraction. Gravity anomalies delineate a series of nearly concentric anomaly patterns that have been related to crater morphology, which are enhanced in the horizontal gravity anomalies [4,7]. The central sector is characterized by high amplitude, high frequency magnetic anomalies, which are related to the central uplift and the magnetic breccias and melt. On the surface, the buried crater is expressed in the semi-circular array of sinkholes referred to as the cenote ring (Fig. 1). Analyses of topographic charts, digital terrain model and GPS measurements indicated the occurrence of a topographic depression related to the cenote circular ring [4,12,16,17].

It has been proposed that Chicxulub ejecta blanket may extend continuously in the peninsula region up to the Albion Island and other sites in Belize [18]. There are no surface outcrops of ejecta deposits and melt inside the crater and the adjacent area. Evidence for proximal ejecta deposits around the crater came from the Universidad Nacional Autónoma de México (UNAM) drilling program in the southern sector [25], where impact breccias were cored in three boreholes