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衝撃変成石英分析に基づくチクシュルーブ・クレーター内部におけるイジェクタ堆積過程の制約
Analysis of shocked quartz grains inside the Chicxulub crater and constraints on ejecta deposition processes.

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Impact cratering is a ubiquitous process which occurs on terrestrial planets and small bodies in the solar system. Geological and geochemical studies of impact craters on Earth provide essential and unique information, such as a three-dimensional structure and lithological characteristics of craters, for understanding impact cratering process. The Chicxulub crater, located in the Yucatan Peninsula in Mexico, is 180-200 km in diameter, which is one of the largest impact structures found on Earth. This impact event is considered to have caused a mass extinction at the Cretaceous-Paleogene (K-Pg) boundary at 66 Ma. Thus, knowledge on the cratering process associated with the Chicxulub impact event will be important both for understanding the cratering process of a large-scale impact and its environmental consequences. However, the detailed formation processes of the Chicxulub crater have been still unknown.

In this study, we analyzed both the size distribution of and planar deformation features (PDFs) on shocked quartz grains contained in the Yaxcopoil-1 (YAX-1) drilling core samples derived from the Chicxulub crater. PDFs are planar micro structures generated under high-pressure conditions (~10-35 GPa). The crystallographic orientation of PDFs is known to preserve information of shock pressure achieved by impacts. We found 525 shocked quartz grains from top to bottom of impactite sequences in the YAX-1 core. In the present study, 574 sets of PDFs were measured from fifteen vertical levels in the impactite sequences.

We found that shocked quartz grains in the impact melt layer (Unit 5) of the YAX-1 core were predominantly undergone high shock pressures (>25 GPa). Whereas, shocked quartz found in other impactite sequences (i.e., Units 6 and 4-1, in ascending stratigraphic order) are mixtures of quartz grains experienced various shock pressures. These results suggest that Unit 5 is likely to have been formed by an outward flow of impact melt-sheet from the transient crater cavity during the central uplift and collapse of the transient crater. In Unit 1, i.e., the uppermost impactite units, we found an opposite correlation between shocked quartz grains undergone high peak shock pressures (>25 GPa) and those undergone medium degree of shock pressures (12-25 GPa) associated with upward grain fining in the sequences. These results strongly support the idea that Unit 1 was repeated impact-induced tsunami deposits. Given both our results of impact melt-sheet origin of Unit 5 and the results of hydrodynamic simulation of the Chicxulub crater, Unit 6, underlying Unit 5, could be interpreted as ejecta curtain deposits. Our results of ejecta curtain deposits of Unit 6 provide the geological evidence that the position of YAX-1 core is located outside the transient crater cavity, which support the hydrodynamic simulations and seismic data of the Chicxulub crater.

キーワード: 衝突現象, クレーター, 衝撃変成石英, チクシュルーブ・クレーター, 平面変形構造 (PDFs)
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