ABUNDANCE, GRAIN SIZE AND PDF ORIENTATIONS OF SHOCKED QUARTZ GRAINS AROUND THE CHICXULUB CRATER. K. Goto[1], Y. Nakano[2], T. Matsui[1], R. Tada[2] and E. Tajika[3], [1]Planetary Exploration Research Center, Chiba Institute of Technology, 2-17-1 Tsudanuma, Narashino, 275-0016 Chiba, Japan, [2]Department of Earth and Planetary Sciences, The University of Tokyo, 7-3-1 Hongo, Tokyo, 113-0033, Japan, [3]Graduate School of Frontier Sciences, The University of Tokyo, 5-1-5 Kashiwanoha, Chiba 277-8561, Japan.

Introduction: Shocked quartz grains with planar deformation features (PDFs) are one of the most reliable evidence for the impact phenomena [e.g., 1]. Shocked quartz grains with PDFs have been found at more than fifty Cretaceous/Paleogene (K/Pg) boundary sites worldwide [e.g., 2, 3]. Analyses for abundance and size of these grains were conducted in many sites, whereas measurements of PDF orientations were conducted only at 16 sites [e.g., 3, 4]. Among them, Nakano et al. [3] conducted systematic study on the variation of PDF orientations at the proximal K/Pg boundary sites. They measured PDF orientations around the Gulf of Mexico and the Caribbean Sea, while the previous measurements of PDF orientations were conducted mainly at the K/Pg boundary sites in North America, Pacific Ocean, and Europe, located more than 3000 km away from the Chicxulub crater.

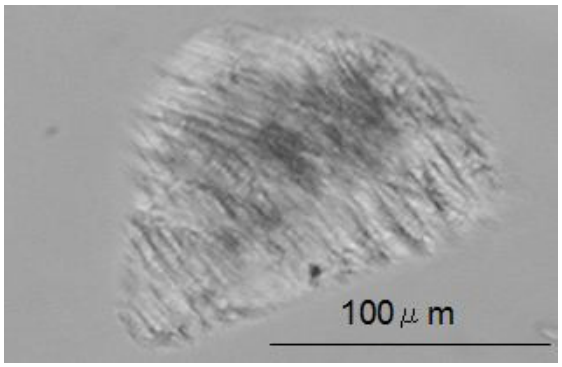

Fig. 1 A thin section photograph of a quartz grain with two sets of PDFs from DSDP Site 540.

Shocked quartz grains with PDFs of the Chicxulub impact origin distributed worldwide [e.g., 2, 5]. Thus, it is possible to study the distribution pattern of quartz grains with PDFs caused by a large impact event. Therefore, we measured abundance, grain size, and PDF orientations of shocked quartz grains (Fig. 1) in the YAXCOPOIL-1 (YAX-1) drilling core inside the crater, DSDP sites 536 plus 540, and the Moncada, the Cacarajícara and the Peñalver formations in Cuba (see Nakano et al. [3] for location) in order to investigate the distribution and variation of shocked quartz grains produced by the Chicxulub impact. All these sites were located up to 800 km from the center of the Chicxulub crater. Especially, we investigated vertical variation of abundance and grain size distribution of shocked quartz grains in detail in each site in order to understand the local sedimentation process of these grains.

Abundance of shocked quartz grains: At DSDP sites and Cuban K/Pg boundary sites, shocked quartz grains are usually observed in the calcarenite layer whereas no or very few shocked quartz grains were observed in the calcirudite layer (Fig. 2). Abundance of shocked quartz grains generally decreases upward with minor fluctuations in each site.

The abundance of shocked quartz grains with PDFs is approximately 31 % in the uppermost impactite sample of the YAX-1, up to 16 % in the samples from the DSDP sites 536 and 540 (Fig. 2), up to 27 % in the samples from the Moncada Formation, and up to 2 % at the Peñalver and Cacarajícara formations [3]. These values are significantly low compared to those at the distal sites. Low abundance of shocked quartz grains at these sites are probably explained by the extensive dilution by the local detrital quartz grains because of the large thickness of K/Pg boundary deposits at our studied sites and presence of a large amount of reworked sediments due to the gravity flows and tsunamis [e.g., 6].

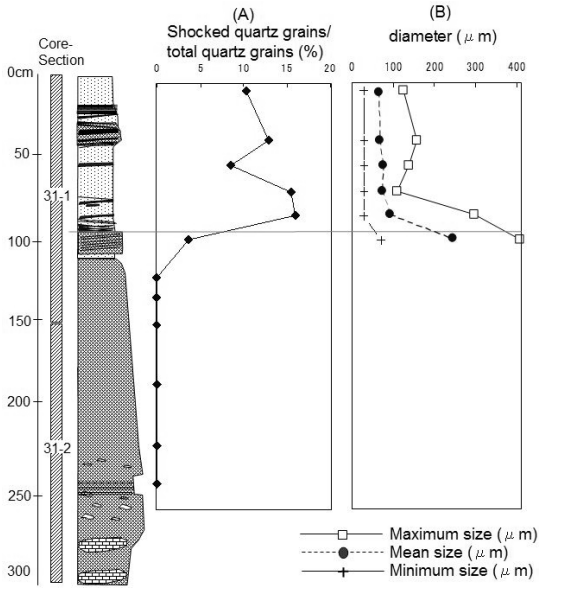

Fig. 2 Vertical variations in (A) abundance of shocked quartz grains within quartz grains of larger than > 32 μm, and (B) maximum, minimum, and mean size of shocked quartz grain (μm) (> 32 μm) in DSDP site 540.

Orientation of PDFs: According to Nakano et al. [3], orientations of PDFs at the studied sites show a broad distribution with peaks at ω, π , and ξ, plus r, z orientations with minor c, s, t plus x, and m plus a orientations. The orientations of PDFs with ξ plus r, z are high in our studied sites, and their frequencies decrease with increasing distance from the crater [3]. Moreover, planar deformation features with c orientation are more abundant in the proximity of the Chicxulub crater than in distal sites, suggesting that part of the shocked quartz grains in the K/Pg boundary deposits in our studied sites were derived from the low shock pressure zones. On the other hand, absence of c and the rare occurrence of PDFs with ξ plus r, z orientations in the uppermost impactite sample from the YAX-1 core suggests that the sampling horizon is also an important factor of variations in PDF orientations of shocked quartz grains [3].

Grain size of shocked quartz: Grain size distribution of each studied site generally shows upward fining feature with minor fluctuations (Fig. 2). This is probably because shocked quartz grains were agitated by the tsunami and then settled onto the sea bottom accordingly depending on their settling velocity.

Mean grain sizes of shocked quartz at the studied sites are up to 250 μm, although the sizes are highly variable depending on the sampling horizons (Fig. 2). This mean size compares well to that in Haiti [7, 8] and North America [e.g. 5], but is larger than at the Pacific Ocean, and Atlantic Ocean sites, and at European localities [5, 9]. As is stated by previous studies [3, 5, 10], the mean size of shocked quartz grain tends to decrease with increasing the distance from the Chicxulub crater.

In the same manner, the maximum grain sizes are up to 400 μm in the studied sites. These sizes may not be representative for those sites, because the investigated sample amounts are very small, whereas the thickness of the K/Pg boundary layer of the studied area are very thick. Nevertheless, the maximum size of shocked quartz grains also decreases with increasing distance from Chicxulub crater [3, 5, 10].

Considering the fact that the pattern of decreasing ejecta-layer thickness and mean and maximum size of shocked quartz grains with increasing distance from the impact crater, the Chicxulub impact was the unique source for the ejecta in the K/Pg boundary event deposits [5, 11].

References: [1] French B. M. (1968) *Shock Metamorphism of Natural Materials, 644 p.* [2] Claeys P. et al. (2002) *Geol. Soc. Am. Spec. Pap.*, *356*, 55–68. [3] Nakano Y. et al. (2008) *Meteoritics & Planet. Sci., 43,* 745–760. [4] Bohor B. F. et al. (1984) *Science*, *224*, 867–869. [5] Morgan J. et al. (2006) *Earth Planet. Sci. Lett. 251*, 264–279. [6] Tada R. et al. (2003) *Mem. Am. Ass. Petrol. Geol. 79*, 582–604. [7] Kring D. A. et al. (1994) *Earth Planet. Sci. Lett. 128.* 629–641. [8] Leroux H. et al. (1995) *Earth Planet. Sci. Lett. 131.* 255–268. [9] Bostwick J. A. and Kyte F. T. (1996) *Geol. Soc. Am. Spec. Pap.*, *307*, 403–415. [10] Bohor B. F. (1990) *Tectonophysics*, *171.* 359–372. [11] Schulte P. et al. (2010) *Science*, *327*, 1214–1218.