

Origin of Moncada Formation in northwestern Cuba and its relation to K/T event

Yoichiro Nakano[1], Ryuji Tada[2], Tomoka Kamata[3], Eiichi Tajika[4], Tatsuo Oji[4], Shoichi Kiyokawa[5], Hideo Takayama[6], Kazuhisa Goto[7], Shinji Yamamoto[8], Kazuhiro Toyoda[9], Manuel A. Iturralde-Vinent[10], Takafumi Matsui[1]

[1] Dept. of Earth and Planetary Phys., Univ. of Tokyo, [2] Geol. Inst., Univ. of Tokyo, [3] Earth and Planetary Phys., Univ. of Tokyo, [4] Geological Institute, Univ. of Tokyo, [5] Dept. of Geology, National Science Museum, [6] NHK Nagoya, [7] Earth Sci., Tokyo Univ, [8] Earth and Planetary Sci., Tokyo Univ, [9] Environ. Earth Sci., Hokkaido Univ., [10] Museo Nacional de Historia Natural

We found a 2m thick KTB layer in Moncada, western Cuba. The locality is considered to have been located on the slope along the southeastern margin of Yucatan Peninsula during the Cretaceous. Therefore, the locality is the one of the closest sites from the Chixulub crater at the time of the impact. Ir and Ni anomaly, shocked quartz and spherule-like grains were found in the formation. These evidences strongly support the relation with the K/T impact. We analyzed major element composition of the bulk samples and conducted Q-mode factor analysis using it to identify possible source materials. Three factors can explain 97.9% of the variance. Factor 1 and 3 as representing impact ejecta dominated by tektite and shocked quartz, respectively. Factor 2 probably represent limestone fragments.

In contrast with a thin K/T boundary (KTB) clay in KTB in Europe, in the Gulf of Mexico and Caribbean regions are characterized by a thick sandstone with abundant impact derived materials. While sedimentary process of KTB in Gulf of Mexico and Caribbean regions are controversial, distribution and quantity of ejecta itself is not well understood. Ejecta blanket of crater is observable on Moon and Mars, but hardly on the Earth because of rarity of large crater and erosion after formation on Earth.

We found a 2m thick KTB layer in Moncada, western Cuba. The locality belongs to Guaniguanico Terrain, that is considered to have been located on the slope along the southeastern margin of Yucatan Peninsula during the latest Cretaceous, and later scraped off from the margin and accreted to the Cuban Island in association with northeastward migration of the Caribbean arc in Paleogene time. Thus, the locality is the one of the closest sites from the Chixulub crater at the time of the impact. Therefore, investigating KTB in Moncada leads to understanding the distribution of ejecta from Chixulub crater.

The KTB layer in Moncada overlies dark gray bedded limestone of late Maastrichtian, and consists of a 185 cm thick sandstone unit overlain by a 4 cm thick siltstone to claystone unit. The sandstone unit is normal graded as a whole, and consists of alternations of coarse to medium grained, olive gray sandstone layers and medium to fine grained, thinner light to dark gray, calcareous sandstone layers. The olive gray sandstone layers are either massive or parallel laminated, whereas dark and light gray calcareous sandstone layers are generally cross laminated. The 4 cm thick siltstone to claystone unit consists of a 2 cm thick purplish brown claystone with thin fine sandstone lenses, a 1cm thick light brownish claystone bed, a 1 cm thick olive gray fine sandstone layer, and a 1 cm thick yellowish brown clay layer in ascending order. The upper siltstone to claystone unit grades upward into gray fissile limestone which is 35 cm thick and then to dark gray bedded limestone of Paleocene.

Ir and Ni anomaly was found in the clay layers of the upper unit. Peak concentration of Ir is 0.89 [ppb], approximately equal to the value at Mimbrol, Mexico (0.92 [ppb]) and 10 times higher than average concentration in crust. Quartz grains with planar deformation feature (PDF) were found throughout the formation. We measured the angle between the c-axis and the pole to PDFs using universal stage. Moderately sheared spherule-like grains are found at 30 to 70 cm level from the bottom. We measured chemical composition of the grains, but different from the spherules of Beloc and Mimbrol. We consider it to be because of diagenetic alteration. These evidences support the relation with the K/T impact.

We analyzed major element composition of the bulk samples and conducted Q-mode factor analysis using it to identify possible source materials. Three factors can explain 97.9% of the variance. Factor 1 is characterized with higher Al, Fe, Si, Ti, K and Mg, Factor 2 with higher Ca, P and Mn, and Factor 3 with higher Na, respectively. Bulk mineral composition is also analyzed to characterize the factors. Factor 1 has strong positive correlation with smectite and illite, Factor 2 has positive correlation with calcite, and Factor 3 has positive correlation with plagioclase, respectively. Since loadings of Factor 1 are higher in olive gray sandstone layers that are characterized with abundant spherule-like grains, whereas loadings of Factor 3 are higher in light and dark gray calcareous sandstone layers that are characterized with abundant quartz and feldspar grains, and since quartz grains in the sandstone unit are dominantly of shocked quartz origin, we consider Factor 1 and 3 as representing impact ejecta dominated by tektite and shocked quartz, respectively. On the other hand, Factor 2 probably represent limestone fragments whose origin is currently under investigation.