EXTRATERRESTRIAL IMPACT RECORDED IN THE UPPER TRIASSIC DEEP-SEA DEPOSITS FROM JAPAN. H. Sato¹, T. Nozaki², A. Ishikawa³, T. Onoue⁴, J.-I. Kimura⁵ and Q. Chang⁶, ¹Ocean Resources Research Center for Next Generation, Chiba Institute of Technology, Chiba, 275-0016, Japan (honami.sato@p.chibakoudai.jp), ²Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Kanagawa, 237-0061, Japan, ³Department of Earth and Planetary Sciences, Tokyo Institute of Technology, Tokyo, 152-8550, Japan, ⁴Department of Earth and Planetary Sciences, Kyushu University, Fukuoka, 819-0395, Japan.

Introduction: The Late Triassic, 237-201 million years ago (Ma), is marked by the formation of several large impact structures on the Earth, including the 90-km-diameter Manicouagan crater in Canada [1]. Late Triassic impact events have been considered as one of the factors affecting biotic extinction events in the Late Triassic (e.g., end-Norian extinction event), but this scenario remains controversial because of a lack of stratigraphic records of impact events. In order to reconstruct the stratigraphic record of impact events in the Late Triassic, we examined a stratigraphic profile of the highly siderophile elements (PGE: Os, Ir, Ru, Pt and Pd) concentrations and osmium isotope ratios (\(^{187}\text{Os}/^{188}\text{Os}\)) from Upper Triassic bedded chert successions from Japan.

Samples and methods: Samples for whole-rock geochemical analysis were collected from chert and claystone layers in the Sakahogi section, Mino Belt of the Japanese accretionary complex, which accumulated in a deep seafloor environment in an equatorial region of the Panthalassa Ocean [2]. PGE concentrations and Os isotope ratios were determined by isotope dilution mass spectrometry (ID-MS) using the high-temperature sample digestion method with inverse aqua regia in closed glass tubes [3, 4].

Results: Evidence of the Late Triassic impact event was discovered from a claystone layer in an Upper Triassic bedded chert succession of the Sakahogi section. This claystone layer shows a high abundance of PGE and negative Os isotope excursion with occurrences of microspherules and Ni-rich magnetite spinels [5]. This claystone layer can be divided into lower and upper sedimentary sublayers. The lower sublayer (~8-mm-thick) contains 10–15% (by rock volume) microspherules in a matrix of clay minerals (mainly illite), cryptocrystalline quartz and hematite.

The geochemical signals of the extraterrestrial impact are recorded in the lower sublayer of the claystone. PGE concentrations of the lower sublayer claystone were 3.1 ppb Os, 28.5 ppb Ir, 42.4 ppb Ru, 24.7 ppb Pt and 9.6 ppb Pd. CI chondrite-normalized PGE values in the lower sublayer claystone are three orders of magnitude higher than those of chert samples. \(^{187}\text{Os}/^{188}\text{Os}\) ratios of the bedded cherts exhibit negative excursions in the lower sublayer claystone. Timing of the negative Os isotope excursion (~0.477 to ~0.126) is almost equivalent to the base of the \(M. \text{bidentata}\) conodont zone. This Os isotope excursion interval has the elevated Os concentrations (3.1 ppb) and low Re/Os ratios (~0.03 [6]). In the upper sublayer claystone, initial \(^{187}\text{Os}/^{188}\text{Os}\) ratios gradually increase from 0.178 to 0.234. These analytical data suggest a significant input of extraterrestrial materials into the deep-sea deposits.

Discussion: PGE concentrations in the claystone layer were used to identify the impactor component [7, 8]. PGE elemental ratios in the claystone layer suggest the impactor origin of (1) a chondrite or (2) an iron meteorite. The Ru/Ir and Pt/Ir ratios of all the claystone samples from the study sites are plotted along the mixing line between chondrites and upper continental crust. Although a chondrite cannot be distinguished from iron meteorites by using PGE/Ir ratios, the claystone layers show Cr/Ir ratios between \(10^2–10^3\), indicating that the claystone layer is clearly contaminated by chondritic material. The size of the impactor can be estimated from the Os isotope ratios assuming the range of the Os amount released from the impactor into seawater. Given the 22–100% release of chondrite-derived Os into seawater, the impactor is calculated to be 3.5–7.8 km in diameter [6, 9]. According to the Earth Impact Effects Program [10], the type and size of the impactor estimated from the PGE and Os isotope data would have produced a crater of about 56–101 km in diameter. The estimated size range of the crater is consistent with the size of the Late Triassic Manicouagan crater (ca. 90 km in diameter) in Canada, which coincides in age with the extinction event (e.g., radiolarians and conodonts) in the Late Triassic.