

IMPACT SPHERULES AND NI-RICH SPINELS IN AN UPPER TRIASSIC (NORIAN) DEEP-SEA DEPOSIT FROM JAPAN

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Introduction: An important ~30 Myr interval during the Late Triassic is marked by the formation of several large impact structures on Earth [1], including the 100-km-diameter Manicouagan crater in Canada, which is one of the largest known Phanerozoic impacts. Although the age of the Manicouagan structure is well constrained by U-Pb dating (~215.5 Ma [2]), deposits containing its ejecta are known only from southwestern Britain [3]. Here, we report that an Upper Triassic deep-sea deposit in Japan contains spherules and Ni-rich spinels that are characteristic of impact ejecta.

Result and discussion: Spherules were discovered from a claystone layer (~5 cm thick) in an Upper Triassic radiolarian chert succession of the Mino Terrane, Central Japan. The chert was deposited at low latitudes on the floor of the ancient Pacific Ocean [4]. An analysis of radiolarian fossils reveals that the claystone layer is correlated with the early Norian stage of the Upper Triassic. The base of the layer contains 10–15% (by rock volume) green spherules. Examination of the basal millimeter of the claystone using a scanning X-ray analytical microscope reveals high concentrations of siderophile elements such as Co and Ni. Spherules range in size from 200 to 300 μm . Synchrotron X-ray diffraction analysis [5] indicates that the spherules are composed mainly of clinocllore. Electron microprobe analysis shows large variations in concentrations of Si, Mg, Al, and Fe among the spherules, along with minor amounts of Mn and K. Some spherules contain a high proportion of small, euhedral to subhedral crystals of oxidized Ni-rich spinels. These spinels are 5–20 μm in size and commonly have dendritic, skeletal, or octahedral morphologies. They are distinguished from typical igneous spinels by high contents of NiO (0.7–3.2 wt.%) and Fe^{3+} . These characteristics of the spinel crystals are similar to those of Ni-rich spinels found at the Cretaceous–Paleogene boundary.

The discovery of spherules with Ni-rich spinels in early Norian claystone from Japan suggests an important sedimentary record of an extraterrestrial impact in the Late Triassic. Although the Manicouagan impact structure would appear to be related to deposition of the claystone, based on an age for the crater of ~215.5 Ma [2], the chemical composition and mineral assemblage of the spherules differ from those of hollow illitic spherules reported from southwestern Britain [3], which are considered to be derived from the Manicouagan. Additional research is needed to confirm the source for the early Norian claystone layer in Japan, as well as to constrain the origin of the clinocllore spherules.

References: [1] Spray J. G. et al. 1998. *Nature* 392:171–173. [2] Ramezani J. et al. 2005. Abstract #321. 19th V. M. Goldschmidt Conference. [3] Walkden G. et al. 2002. *Science* 298:2185–2188. [4] Ando A. et al. 2001. *Journal of Geophysical Research* 106:1973–1986. Nakamura T. et al. 2001. *Geochimica et Cosmochimica Acta* 65:4385–4397.