Suspect cubic diamond "impact" proxy and a suspect lonsdaleite identification

The presence of nanometer-sized diamonds in purported Younger Dryas (YD) boundary-dated sediments, carbon spherules, and Greenland ice was cited as evidence of a YD impact event (1). Although cubic and hexagonal (lonsdaleite) diamond have been found in shocked metamorphosed meteorites and are associated with terrestrial impact structures, cubic diamonds are well known to occur in terrestrial deposits that have no associations with impact processes. For example, submicron and smaller cubic diamond crystals have been found recently in carbonaceous spherules isolated in upper soils from various German and Belgian sites (2). Lacking links to impact structures, these diamonds are evidently not products of impact processes. Therefore, the value of cubic diamonds as impact markers is suspect. Israde-Alcántara et al. (1) quoted Tian et al. (3) as independent confirmation of nanodiamonds in YD boundary sediments; however, they failed to mention that sediment horizons above and below the Belgian YD boundary were not studied and, given the presence of diamonds in upper soils, that cubic nanodiamonds may be distributed throughout the Belgian sediments.

Lonsdaleite, on the other hand, is often associated with shock pressures related to impacts where it has been found to occur naturally. However, lonsdaleite has been reported occurring within metamorphosed and metasomatically modified rocks of the Kumdykol diamond deposit, as well as in Yakutite-carbonados; Ukrainian shield titanium placers; Yakutiya diamond placers; and eclogites in Sal'niye Tundra, Kola Peninsula, and the Urals (2). Therefore, its presence in sediments can suggest (but not necessarily prove) shock processing of materials.

What is relevant to the impact hypothesis is whether lonsdaleite is present in YD-aged materials while also being absent in younger and older associated strata. A study of YD boundary sediments sampled from the same collection sites as in Kennett et al. (4) demonstrated that Kennett et al. (4) misidentified graphene/graphane aggregates as lonsdaleite (2). Tian et al. (3) also found no evidence of lonsdaleite in Belgian YD boundary sediments. The high-resolution (HR) lattice image of a nanocrystal from residues of Greenland ice, exhibiting a 1.93-Å lattice spacing and identified as lonsdaleite (5), is clearly crystallographically inconsistent with lonsdaleite (cubic diamond, graphite, and graphene) and *must* be a nondiamond (and likely noncarbon) mineral (2). No crystallographic direction of lonsdaleite exists that can display two different sets of 2.06-Å spaced {002} planes, as shown in figure 6 of Kurbatov et al. (5). Israde-Alcántara et al. (1), sharing many of the coauthors of Kennett et al. (4) and Kurvatov et al. (5), also reported lonsdaleite in purported YD-aged lake sediments in Mexico. This identification is problematic, being based on a fast Fourier transform (FFT) of an HR-lattice image of a nanocrystal that is not imaged along a high-symmetry zone axis. Only one set of lattice planes is discernible in the HR lattice image [figure 8 of Israde-Alcántara et al. (1)]. Provided the weak ~2.16-Å peak in the FFT is not an artifact, the FFT is consistent with the lonsdaleite structure. However, it is also consistent with other materials oriented along various zone axes (2).

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