The Cretaceous-Paleogene crisis: why looking for iridium?

Since the theory of a meteorite impact has emerged as the explanation for the Cretaceous-Paleogene crisis, the main argument is still the discovery of an "abnormal" quantity of **iridium** in the sedimentary layers corresponding to the Cretaceous-Paleogene boundary. The discovery of a "peak of abundance" of this transition metal, normally almost absent from the Earth's continental crust, was indeed the main argument for this theory. But why did the authors of this discovery search for this very rare element (and others, such as osmium)? And why does the "peak" they found suggest that a **large** impact occurred 66 million years ago?

Figure 1. Luis W. Alvarez (1911-1988, left) and his son Walter (right) at the Gubbio site in Italy, in front of the Cretaceous-Paleogene boundary layer in which they measured iridium concentrations. [Source: US Government (Lawrence Berkeley Laboratory) [Public domain], via Wikimedia Commons]

At least two teams had engaged in this type of research in the late 1970s. Today, the anteriority of the discovery is attributed to the group of American geologist Walter Alvarez of Mexican origin, associated with physicist Luis Alvarez (1911-1988), his father, and chemists Franck Asaro and Helen W. Michel. The idea of these researchers was to quantify the duration of the small layer of clay corresponding to the Cretaceous-Paleogene boundary in the European terrain. Walter Alvarez assumed that this duration was longer than it seemed, *i.e.* that sedimentation had slowed down at the end of the Cretaceous, condensing a significant duration into a small thickness of deposits.

To estimate the rate of sedimentation, one method consists in measuring the concentrations of a substance that is normally non-existent or very rare in terrestrial surface rocks, but brought to Earth from space, *i.e.* independently of fluctuations in erosion and sedimentation: if the sedimentation slows down, this substance will be concentrated in a small thickness of sediment; conversely, an acceleration of sedimentation will dilute it in the mass of the deposits. However, the physicist Luis Alvarez (winner of the Nobel Prize in Physics in 1968) was a specialist in the measurement of very small quantities of rare chemical elements in terrestrial rocks.

Iridium and osmium, among others, are almost absent from the earth's crust (on average, for iridium, 0.1 nanograms per gram of rock) because they essentially accompanied iron in the Earth's core during the differentiation of the Earth more than 4.4 billion years ago. But these elements are more abundant in ancient meteorites, relics of the materials that, by agglomerating, melting and differentiating under the influence of gravity, formed telluric planets like the Earth. Micrometeorites of this type arrive quite frequently on Earth in an incessant "rain" on a geological time scale.

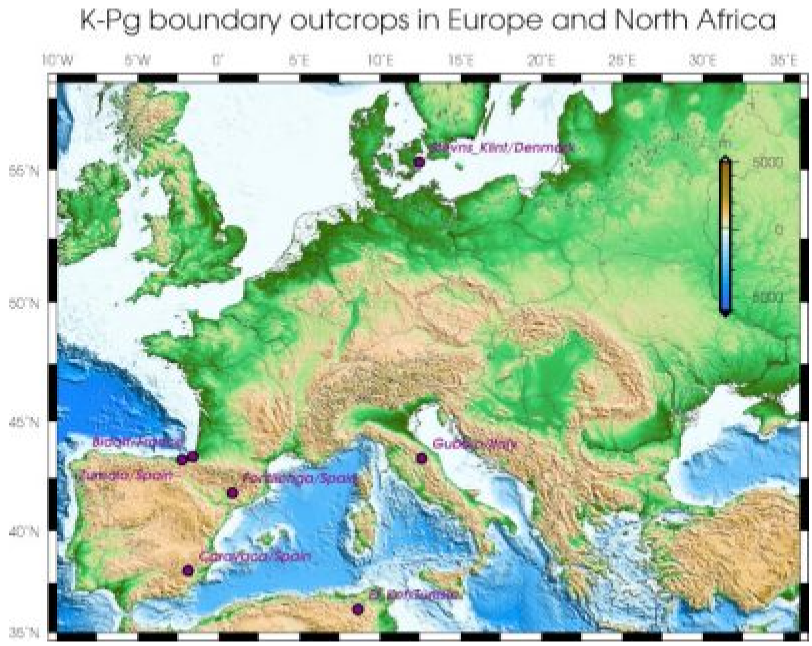

Figure 2. Some places in Europe and North Africa where the Cretaceous-Paleogene boundary is exposed. The El Kef site in Tunisia is now the reference outcrop for this boundary of the geological time scale. [Source: © C. Langlois]

Luis and Walter Alvarez *therefore expected to measure a "peak" of iridium and osmium* in the clays of the Cretaceous-Paleogene boundary (Figure 2), which would have shown a slower sedimentation rate. But the peak they measured, although very small (about 100 nanograms of iridium per gram of sediment, compared to about 0.25 ng/g in older and newer sediments), turned out to be much larger than they expected (between 20 and 160 times the base value of the surrounding rocks). If this iridium came from the flow of micrometeorites, such a concentration, found in Italy, the Netherlands and as far away as New Zealand, implied a cessation of sedimentation for several million years! After considering other possible explanations, which they did not consider more satisfactory or more likely, Walter Alvarez and his colleagues developed the theory, contrary to their initial hypothesis, of a massive supply of iridium by a large meteorite, therefore a sudden and never observed event. The impact crater that could correspond to this cataclysmic event was not discovered until a decade later [1].

References and notes

[1] Langlois C. (2014), *La crise Crétacé-Paléogène et l'hypothèse météoritique, 34 ans après*. Online (http://planet-terre.ens-lyon.fr/article/limite-K-Pg-meteorite.xml).

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