# Paper announces discovery of one of earliest minerals formed in solar system

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In the May-June issue of the journal *American Mineralogist*, a team of scientists announced the discovery of the new mineral krotite, one of the earliest minerals formed in our solar system. It is the main component of an unusual inclusion embedded in a meteorite (NWA 1934), found in northwest Africa. These objects, known as refractory inclusions, are thought to be the first planetary materials formed in our solar system, dating back to before the formation of the Earth and the other planets.

This particular grain is known affectionately as "Cracked Egg" for its distinctive appearance. Dr. Harold C. Connolly, Jr. and student Stuart A. Sweeney Smith at the City University of New York (CUNY) and the American Museum of Natural History (AMNH) first recognized the grain to be of a very special type, known as a calcium-aluminum-rich refractory inclusion. ("Refractory" refers to the fact that these grains contain minerals that are stable at very high temperature, which attests to their likely formation as very primitive, high-temperature condensates from the solar nebula.)

Cracked Egg refractory inclusion was sent to Dr. Chi Ma at California Institute of Technology (Caltech) for very detailed nano-mineralogy investigation. Dr. Ma then sent it to Dr. Anthony Kampf, Curator of Mineral Sciences at the Natural History Museum of Los Angeles County (NHM), for X- ray diffraction study. Kampf's findings, confirmed by Ma, showed the main component of the grain was a low-pressure calcium aluminum oxide ($CaAl_2O_4$) never before found in nature. Kampf's determination of the atomic arrangement in the mineral showed

it to be the same as that of a man-made component of some types of refractory (high-temperature) concrete.

What insight can we get from knowing that a common man-made component of modern concrete is found in nature only as a very rare component of a grain formed more than 4.5 billion years ago? Such investigations are essential in deciphering the origins of our solar system. The creation of the man-made compound requires temperature of at least 1,500°C (2,732°F). This, coupled with the fact that the compound forms at low pressure, is consistent with krotite forming as a refractory phase from the solar nebula. Therefore, the likelihood is that krotite is one of the first minerals formed in our solar system.

Studies of the unique Cracked Egg refractory inclusion are continuing, in an effort to learn more about the conditions under which it formed and subsequently evolved. In addition to krotite, the Cracked Egg contains at least eight other minerals, including one other mineral new to science.

**More information:** The American Mineralogist paper is entitled "Krotite, CaAl2O4, a new refractory mineral from the NWA 1934 meteorite."

Provided by Natural History Museum of Los Angeles County