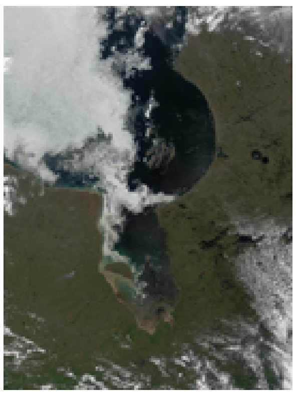
# Young graphite, old rocks: looking for evidence of earliest life

May 17 2011



This picture of the Hudson Bay in Canada is courtesy of Jacques Descloitres, MODIS Land Rapid Response Team, provided as part of NASA's Visible Earth program.

(PhysOrg.com) -- Scientists have long debated about the origin of carbon in Earth's oldest sedimentary rocks and how it might signal the remnants of the earliest forms of life on the planet. New research by a team including five scientists from Carnegie's Geophysical Laboratory and Department of Terrestrial Magnetism discovered that carbon samples taken from ancient Canadian rock formations are younger than the sedimentary rocks surrounding them, which were formed at least 3.8 billion years ago. Their results, published online May 15 by *Nature Geoscience*, indicate that the carbon contained in such ancient rocks should not be assumed to be as old as the rocks, unless it can be shown to have had the same metamorphic history as the host rock.

Sedimentary rocks consist of layers of materials that are deposited over time. Some of Earth's oldest sedimentary rocks are the so-called banded iron formations. It has been proposed that these formations may contain remnants of ancient iron-metabolizing microbes. Scientists theorize that these remains could be found in the associations between carbon-containing materials and apatite--a common biomineral in nature and the main mineral in human bones. Carbon is the building block for all organic compounds and the key element for the presence of life. However, it is difficult to pinpoint the source of carbon in these remnants, because the sedimentary rocks have been so altered over time by chemical and thermal processing.

Although previous studies analyzed rock samples collected from West Greenland this new research focused on Canadian rock formations. The team, lead by Geophysical Laboratory's Dominic Papineau, collected dozens of rock samples from an area called the Nuvvuagittuq Supracrustal Belt in northern Québec, on the eastern shore of the Hudson Bay. The sampled rocks are between 3.8 and 4.3 billion years old. Two samples that contained abundant apatite and carbonaceous material associations were analyzed in detail.

The carbonaceous material was in a form similar to graphite, known for its use in pencils. Spectroscopic analysis indicated that the type of graphite is poorly crystallized. Calculated estimates of the temperatures at which this poorly crystallized graphite formed were significantly lower than the highest temperatures experienced by the surrounding host rocks. These results show that the graphite was formed after the time that the majority of the other minerals in the rock samples were created due to heating and chemical processing. This means that the carbon is younger than the rock itself!

Carbon isotopes in carbonaceous material studied by the team were similar in composition to those found in comparable samples from

Greenland. These Greenland samples had been interpreted as evidence of the earliest life on Earth. But the Carnegie team's new results demonstrate that more research is needed to determine whether or not the carbon samples are biologic in origin.

"More research is needed to assess whether graphitic carbon in the oldest sedimentary rocks belongs to these rocks and if it indicates the existence of microbial ecosystems on the earliest Earth," lead author Papineau said.

The team proposed that biologically-derived carbon in the rock samples could have come from fluids that were deposited along with the apatite or from carbon-containing molecules that infiltrated the rock more recently.

"Further study is required to fully understand the formation of carbonaceous material in these ancient sedimentary rocks," Papineau said. "But these exciting results open up the world of research on the earliest life in the oldest rocks to areas outside Greenland, giving us a broader understanding of the links between mineral and biological evolution on the early Earth."

Provided by Carnegie Institute