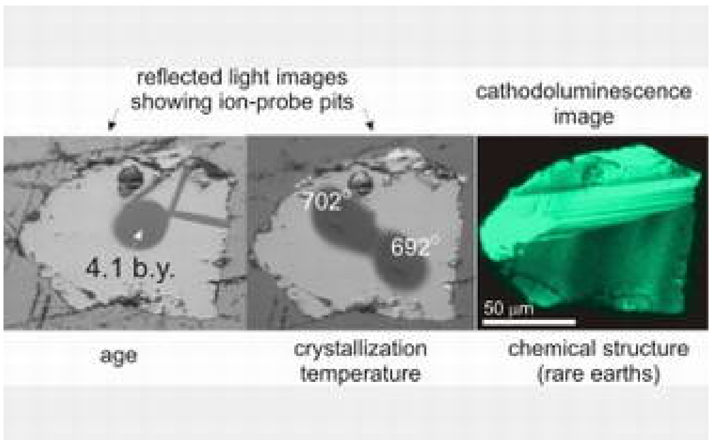
# New study: Hell not as bad as we thought

May 6 2005




The very earliest years of Earth have long been presumed hot, violent and terrible – so much so that the era from 4.5 billion years to 4 billion years ago is known as the Hadean Eon, or Hellish time.
However, a four-year study of the oldest known minerals on Earth, published in this week's Science magazine, has found that Hadean is most probably a misnomer.
Using a newly developed thermometer made of zircon, researchers have found evidence that environmental conditions on early Earth, within 200 million years of the solar system's formation, were characterized by liquid-water oceans and continental crust similar to those of the present day.

*image: A single zircon from Earth's earliest history shows ion-probe age*

*(1); crystallization temperatures (2); and internal chemical structure (3). Credit: Bruce Watson, Rensselaer Polytechnic Institute.*

Research by ANU Geologist Professor Mark Harrison and Professor Bruce Watson from the US Rensselaer Polytechnic Institute found that rocks were formed in a controlled, ordered manner in the early Earth.

“It’s been an article of faith that the Hadean period was a hellish time, but it’s time to come up with a new name,” Professor Harrison said.

“Theorists have traditionally painted the early Earth as a hellish, desiccated place, suggesting rocks on Earth would have been formed as a result of frequent impacts of meteorites. However, this would have produced rocks that were formed at very high temperatures and bone dry – but we found the opposite. This wasn’t a time of chaos. Rocks were made in a controlled and ordered way, in many ways similar to the modern era.

“The chances are that if you showed up for an afternoon on the early Earth you would have seen blue oceans and sky, continents sticking out with roughly the same mass that we have today, and a fairly ordered environment.”

The researchers devised a unique method of assessing the temperature at which rocks formed, by examining titanium content in zircons - small crystals that are created during rock formation. While the ancient rocks themselves have eroded, small quantities of the ancient zircons were discovered 20 years ago embedded in ancient sedimentary rock in the Jack Hills, Western Australia, about 350 km north of Perth.

Zircons, typically no larger than the width of a human hair, were extracted from the crushed rock by hand, then scanned using the ANU Sensitive High Resolution Ion Micro Probe (SHRIMP) to determine their age. Over the past four years, 40,000 zircons have been scanned, yielding only a few hundred that are 4.2 billion years or older.

Titanium concentrations in each zircon provided an accurate indicator of the temperature at which the zircons had crystalised. By measuring titanium concentration in over 50 of these ancient zircons ranging from 4.0 to 4.35 billion years old, the researchers were able to get an accurate measure of the temperatures at which the rocks formed.

“Rocks formed as a result of the thermal energy from meteorite impacts would be bone dry and melt at 900 degrees to 1200 degrees Celsius,” Professor Harrison said.

“In contrast, our study has found that Hadean rocks melted at a consistent average temperature of 690 degrees Celsius. Water, which is a very powerful catalyst, must have been present in very large amounts for rocks to melt at such a relatively low temperature.

“There are no zircons we have examined which were made at temperatures hotter than 800 degrees Celsius. Clearly there were impacts of rocks from outer space, but big impacts would have been millions of years apart and it would have at least been hundreds of years between local small disturbances.”

For there to be sufficient water to act as a catalyst in rock formation at the relatively shallow depths at which these zircons formed, the researchers say there would have had to have been an atmosphere around Earth, to prevent water from dissipating into Outer Space, and oceans at this time. This finding supports the ‘Waterworld’ hypothesis – that oceans had appeared on Earth by 4.3 billion years ago – that Professor Harrison and his colleagues proposed four years ago, based on oxygen isotope evidence from these ancient zircons.

“This has profound implications for answering the question: When did the Earth became habitable for life? Virtually all researchers agree that life could not have emerged until there was liquid water at or near the Earth’s surface. Thus the Earth may have harboured life for as much as 700 million years longer than currently believed,” Professor Harrison said.

Source: ANU, NSF

Citation: New study: Hell not as bad as we thought (2005, May 6) retrieved 31 March 2023 from https://phys.org/news/2005-05-hell-bad-thought.html