Researcher unravels one of geology's great mysteries

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Danish researcher has solved one of the great mysteries of our geological past: Why the Earth's surface was not one big lump of ice four billion years ago when sun radiation was much weaker than today. Scientists have presumed that the Earth's atmosphere back then consisted of 30 percent CO_2 trapping heat like a greenhouse. However, new research shows that the reason for Earth not going into a deep freeze at the time was quite different.

In 1972, the late, world famous astronomer Carl Sagan and his colleague George Mullen formulated "The faint early sun paradox. " The paradox consisted in that the earth's climate has been fairly constant during almost four of the four and a half billion years that the planet has been in existence, and this despite the fact that radiation from the sun has increased by 25-30 percent.

The paradoxical question that arose for scientists in this connection was why the earth's surface at its fragile beginning was not covered by ice, seeing that the sun's rays were much fainter than they are today. Science found one probable answer in 1993, which was proffered by the American atmospheric scientist, Jim Kasting. He performed theoretical calculations that showed that 30% of the earth's atmosphere four billion years ago consisted of CO_2. This in turn entailed that the large amount of greenhouse gases layered themselves as a protective greenhouse around the planet, thereby preventing the oceans from freezing over.

Mystery solved

Now, however, Professor Minik Rosing, from the Natural History Museum of Denmark, and Christian Bjerrum, from the Department of Geography and Geology at University of Copenhagen, together with American colleagues from Stanford University in California have discovered the reason for "the missing ice age" back then, thereby solving the sun paradox, which has haunted scientific circles for more than forty years.

Professor Minik Rosing explains, "What prevented an ice age back then was not high CO_2 concentration in the atmosphere, but the fact that the cloud layer was much thinner than it is today. In addition to this, the earth's surface was covered by water. This meant that the sun's rays could warm the oceans unobstructed, which in turn could layer the heat, thereby preventing the earth's watery surface from freezing into ice. The reason for the lack of clouds back in earth's childhood can be explained by the process by which clouds form. This process requires chemical substances that are produced by algae and plants, which did not exist at the time. These chemical processes would have been able to form a dense layer of clouds, which in turn would have reflected the sun's rays, throwing them back into the cosmos and thereby preventing the warming of earth's oceans. Scientists have formerly used the relationship between the radiation from the sun and earth's surface temperature to calculate that earth ought to have been in a deep freeze during three billion of its four and a half billion years of existence. Sagan and Mullen brought attention to the paradox between these theoretical calculations and geological reality by the fact that the oceans had not frozen. This paradox of having a faint sun and ice-free oceans has now been solved."

CO_2 history iluminated

Minik Rosing and his team have by analyzing samples of 3.8-billion-yearold mountain rock from the world's oldest bedrock, Isua, in western Greenland, solved the "paradox".

But more importantly, the analyses also provided a finding for a highly important issue in today's climate research - and climate debate, not least: whether the atmosphere's CO_2 concentration throughout earth's history has fluctuated strongly or been fairly stable over the course of billions of years.

"The analyses of the CO_2-content in the atmosphere, which can be deduced from the age-old Isua rock, show that the atmosphere at the time contained a maximum of one part per thousand of this greenhouse gas. This was three to four times more than the atmosphere's CO_2-content today. However, not anywhere in the range of the of the 30 percent share in early earth history, which has hitherto been the theoretical calculation. Hence we may conclude that the atmosphere's CO_2-content has not changed substantially through the billions of years of earth's geological history. However, today the graph is turning upward. Not least due to the emissions from fossil fuels used by humans. Therefore it is vital to determine the geological and atmospheric premises for the prehistoric past in order to understand the present, not to mention the future, in what pertains to the design of climate models and calculations," underscores Minik Rosing.

Professor Rosing's scientific research has made its mark internationally on several earlier occasions, including research on the point in time when the first fragile life appeared and the impact of life's presence on the formation of the earth's landmass.

Provided by University of Copenhagen