Water flowed early in the solar system

As the sun emerged from its cocoon of gas and dust, tiny bits of ice and rocky debris began gathering in a frigid, flattened disk surrounding the infant star. But things started heating up in a hurry. A new study suggests that temperatures in some parts of the disk were warm enough for liquid water to exist on the first solid bodies in the solar system just 20 million years after they had formed. That's at least 30 million years earlier than indicated by previous evidence.

The new finding, based on a highly accurate method for the radioactive dating of primitive meteorites, pinpoints one of the earliest and most important events in the solar system—the time at which frozen water became liquid.

Magnus Endress and Adolf Bischoff of the University of Münster in Germany and Ernst Zinner of Washington University in St. Louis report their work in the Feb. 22 NATURE.

To study the early solar system, the researchers examined samples of the most primitive type of meteorite known—type I carbonaceous chondrites, or CI chondrites. Scientists think that they are fragments of asteroid-size parent bodies and that the carbonates in them represent sediments deposited by running water. Researchers use radioactive dating to estimate the time that elapsed from the formation of the parent body to the deposition of carbonates.

A standard method using strontium isotopes had indicated that liquid water made its debut sometime within the first 50 million years after solid bodies formed. To get more accurate timing of these early events, Endress and his colleagues needed to trace an isotope with a half-life of no more than a few million years—short enough to reflect activity within the first 10 million years of the solar system.

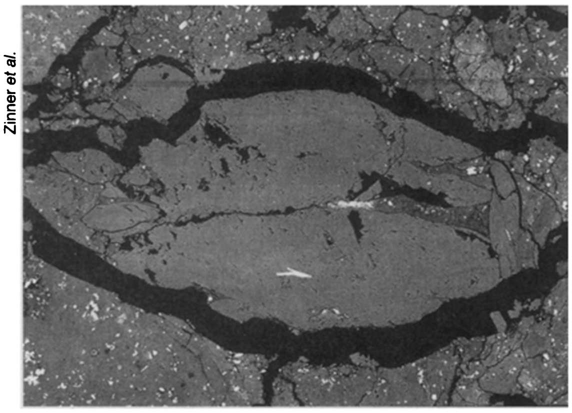
Aluminum-26 and manganese-53 both fill the bill. Although these isotopes have by now decayed completely, researchers can infer their presence in the early solar system by looking for an excess abundance of their decay isotopes. Endress and his collaborators chose to study chromium-53, the daughter isotope of manganese-53, in carbonate fragments of the two CI chondrites known as Ivuna and Orgueil. They find that water began to liquefy no later than 20 million years after the creation of the oldest known solid materials.

"It's been a very difficult measurement... and these people have succeeded," says Harry Y. McSween of the University of Tennessee in Knoxville.

By calibrating the timing of an event that occurred within the first several million years of the 4.5-billion-year-old solar system, the researchers have accomplished the equivalent of determining at 3-day intervals the infant characteristics of a person now 45 years of age, notes Ian D. Hutcheon of the Lawrence Livermore (Calif.) National Laboratory. In a commentary accompanying the NATURE article, he writes that in order to melt ice so early in the solar system, the temperature of the parents of the CI chondrites must have risen from less than 150 kelvins to about 420 kelvins in at most 15 million years.

Hutcheon says the timing reveals that water became liquefied on the parents of the CI chondrites at the same time that other meteorites were undergoing severe heating that altered their composition.

The timescale, says McSween, offers good news for researchers who maintain that heat released by the radioactive decay of aluminum-26 melted ice on the parent bodies. He and Robert Grimm of Arizona State University in Tempe had proposed such a theory in 1989 but were stymied by arguments that water had remained frozen for 50 to 100 million years—long after the short-lived aluminum isotope would have expired.



Zinner *et al.*

Carbonate shard of the Orgueil meteorite.

The existence of liquid water so early in the solar system may have hastened the creation of life on Earth, notes McSween. When water and simple organic molecules react, they generate complex organic compounds, the precursors to life. If such compounds had already appeared by the time Earth assembled, they might have formed a veneer of life-supporting chemicals on our planet, he speculates. *—R. Cowen*

The Antarctic dilemma: Blowing in the wind

Sitting high and dry in the middle of a vast, icy continent, the South Pole is a strange place to find ocean algae. So when Davida E. Kellogg and Thomas B. Kellogg found the shells of diatoms in a South Pole ice core some 1,200 kilometers from the nearest open ocean, they reasoned that the algae must have hitched a ride on the wind to the remote Antarctic site.

The discovery provides some potentially heartwarming news for anyone concerned about the possibility of Antarctica's melting away. The work calls into question suggestions that the great ice sheet shriveled during a warm episode in the recent geologic past, says Davida Kellogg. The researchers, both at the University of Maine in Orono, report their findings in the February GEOLOGY.

Close to 90 percent of the ice in Antarctica lies in the eastern part of the continent. If this East Antarctic ice sheet melted, it would swell sea levels by 60 meters, enough to drown parts of New York and many other coastal cities.

Most climate experts regard East Antarctica's ice as a remarkably stable feature that has persisted for at least 14 million years. In the mid-1980s, however, a small group of scientists from Ohio State University in Columbus undermined that staid reputation. They claimed that much of Antarctica melted away 3 million years ago, during a warm period in the Pliocene epoch.

The Ohio group's evidence comes in the form of tree fossils and sedimentary deposits left by bodies of water that at some time covered parts of now ice-bound Antarctica. The tree fossils could not be dated. But by dating marine diatoms found within the so-called Sirius group sediments, the scientists deduced that the trees lived less than 3 million years ago. According to their theory, the ice sheet melted during the Pliocene warmth, trees thrived, and then the ice formed again.

The Maine researchers propose another explanation for the Sirius group diatoms. If the wind blows algae across Antarctica, then the 3-million-year-old species could have dropped on much older sediments containing the tree fossils. "[Our work] does cast doubt on the warm Pliocene model," says Davida Kellogg.

Last year, another group reached similar conclusions after finding 8-million-year-old ice within a valley in East Antarctica (SN: 8/5/95, p. 87).

"There's now going to be a lot more doubt about the diatoms in the Sirius group deposits," admits David Harwood of the University of Nebraska in Lincoln. Despite the new evidence, Harwood and his coworkers at Ohio State continue to support the idea of a Pliocene meltdown.

To help resolve the debate, he and his colleagues collected additional samples of Sirius group rocks during the recent Antarctic field season. By looking below the surface, they hope to determine whether the diatoms were windborne. The answers will not come quickly, though. The laborious process of identifying the diatoms may take a year.

—R. Monastersky