Biology

Stefi Weisburd reports from Edmonton, Alberta, at the 24th annual meeting of the Society for Cryobiology

The bun also rises with freeze-hearty yeast

There's nothing quite as deflating as baking a bread that never rises because the yeast in the dough has lost its zest. The problem has inspired the Montreal-based Lallemand, Inc., a company that grows and sells yeast to companies that make frozen doughs, to attempt to develop freeze- and thaw-resistant strains of yeast. The demand for such yeast and for frozen dough is expanding, says Chris Toupin at St. Hyacinthe Food Research Center in Quebec. Bakeries and restaurants can store large amounts of one batch of dough for long periods of time, using it only as needed; proprietors want to know that the quality of the resulting breads and croissants will be consistent.

So Lallemand's Pierre Gélinas, Toupin and their colleagues varied the conditions under which Baker's yeast is cultured until they found the one that produced the most hearty strain. The yeast was stored in miniature doughs at -30 ° C for up to six months, and then the volumes of the dough were compared when they were subsequently cooked.

In order to understand why some strains survived freezing and thawing while others died, the researchers examined the permeability, flexibility and composition of the yeast membrane. They discovered that the heartiest yeast is most permeable to water. This probably allows water to move out of the yeast quickly during freezing, says Toupin, so that damaging ice crystals do not form inside the yeast cells. In addition, having flexible membranes also appears to help the yeast cells survive the large changes in volume that accompany freezing and thawing and that can often kill or compromise a cell.

Toupin says that there are differences in the amount of one type of lipid that makes up the membrane of the yeast, but his group has yet to completely understand the link between composition and behavior of the membrane.

The best part of this research, adds Toupin, is that he and his co-workers get to eat the baked results of their experiments.

Musseling in on novel cryoprotectants

Cryobiologists have long known that many insects and some frogs are equipped with compounds that protect them against the damaging effects of freezing. Bivalve mollusks and other invertebrates that live near shore also weather frigid temperatures and are able to survive the presence of ice in their extracellular fluids. But until recently, scientists had been unable to find any similar cryoprotectants in these animals.

Stephen Loomis at Connecticut College in New London and John Carpenter and John Crowe at the University of California at Davis report that they have identified at least two novel compounds in the blood of winter-acclimatized blue mussels, which protect one kind of membrane and two enzymes against freezing and thawing damage. In a systematic purification process, they identified taurine, which previously had been shown to stabilize membranes under nonfreezing conditions, and strombine, which is produced when the animal shuts its shell, sealing off its access to oxygen. Loomis says that the finding of strombine may explain past reports that linked such anaerobic conditions to increased freezing tolerance of the animal.

Past efforts to find a cryoprotectant in these intertidal organisms failed because scientists had only searched for well-known cryoprotectants such as glycerol, he says. With his group's method of systematically separating components of blood by size and weight and then testing their cryoprotective properties, Loomis hopes to identify new cryoprotectants in other freeze-tolerant animals such as a tidal marsh snail. His group is also working to understand exactly how the recently found compounds may protect the blue mussel from the ravages of freezing and thawing.

Space Sciences

Watering Mars with volcanism

The role of water may not be the ultimate question in the study of the planet Mars, but it is an essential factor in understanding the answer(s). Was Mars once wetter? Warmer? More earth-like? It is a vastly complicated problem, from the amount of water originally present within the planet to the quantities that remain today in such diverse reservoirs as permafrost, hydrated minerals and perhaps even subterranean aquifers of liquid.

Various estimates of the total volume of water on Mars have been based on such factors as the distribution of elements throughout the solar system, studies of certain meteorites believed to have come from Mars, examination of what appear to be water-carved "outflow channels" on the Martian surface and more. Few of these studies, however, says Ronald Greeley of Arizona State University in Tempe, have dealt with the amounts and timing of water released from the planet's interior in the course of its evolution.

Some of the water would have been present since the planet's formation, but much would have formed later on in association with volcanism, the evidence of which is visible in thousands of the photos taken by the two Mars-orbiting Viking spacecraft. Greeley estimates in the June 26 SCIENCE that volcanism could have accounted for the equivalent of a water layer 46 meters deep over the entire planet. (Previous water estimates, he says, not confined to the role of volcanism, have ranged from 1 meter to 1 kilometer.)

In 1979, he and a colleague concluded from the Viking photos that volcanism has "resurfaced" more than 41 percent of the Martian surface, by their best estimate, and that the total could be as high as 64 percent (SN: 11/10/79, p. 329). Recently prepared global geologic maps based on the Viking data, says Greeley, still indicate that materials apparently of volcanic origin cover more than half the surface.

Constructing a panorama of Martian water history from such a finding, however, is a formidable task. It is one of the key issues that have been addressed in recent years as part of a NASA-funded multidisciplinary research project called MECA, or Mars: Evolution of its Climate and Atmosphere. A major problem is the lack of knowledge about the amount of volatile materials, or gases, in Martian magmas. Even for earth, Greeley says, such calculations have large uncertainties, and extrapolating them to Mars just makes them more uncertain. Another difficulty, long familiar to planetary geologists, is assigning ages to surface features, since almost the only available tool (in the absence of actual rock samples that can be dated) is to count visible meteorite craters and attempt to relate their number to how long a given surface has been exposed to impacts.

Acknowledging these problems, Greeley nonetheless cites a general history of Martian volcanism in terms of "age scales" estimated for major Martian geologic epochs by another researcher (Kenneth L. Tanaka of the U.S. Geological Survey in Flagstaff, Ariz.). As for the amount of water associated with those upheavals, he uses a figure of 1 percent by weight, based on comparisons with earth and the assumption that Martian volcanism is dominated by mafic materials.

"Most of this water," according to Greeley, "was released in the first 2 billion years of Martian history." However, he notes, "volcanism has occurred from at least the close of the period of heavy impact cratering (about 3.9 billion years ago) to the age of the youngest rocks visible on the planet." And since the volcanism probably did not only form water from magmatic volatiles but also released substantial quantities that had already existed beneath the surface, he says, "the results substantiate the growing perception of Mars as a 'wet' planet in the first third of its history."