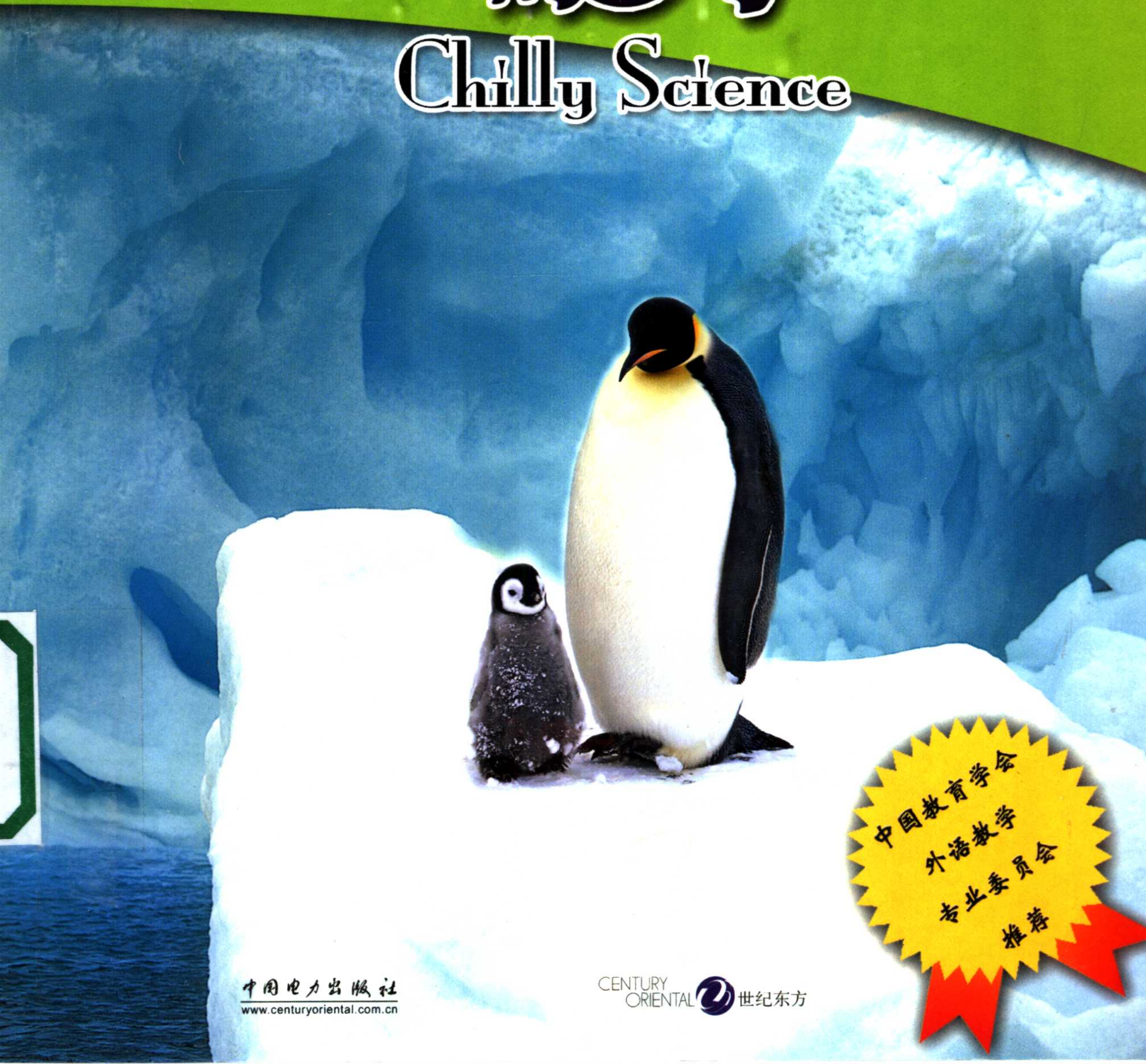
阅读空间 · 英汉双语主题阅读

寒冷的科学

Chilly Science

高中和大学低年级适用



中国教育学会外语教学专业委员会推荐

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余嘉 译

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京权图字 01－2004－4373
图书在版编目（CIP）数据

寒冷的科学／美国蔻博斯通出版公司编著；余嘉译．
北京：中国电力出版社，2005
（阅读空间·英汉双语主题阅读）
书名原文：Chilly Science
ISBN 7-5083-2679-2

Ⅰ.寒… Ⅱ.①美…②余… Ⅲ.英语－阅读教学－
高中－课外读物 Ⅳ.G634.413

中国版本图书馆 CIP 数据核字（2004）第 074430 号

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《阅读空间·英汉双语主题阅读》由美国北极星传媒有限公司授权出版，
北京行走出版咨询有限公司策划

寒冷的科学

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丛书策划：北京行走出版咨询有限公司
翻　　译：余　嘉
责任编辑：赵伟宏　李宝琳
出版发行：中国电力出版社
社　　址：北京市西城区三里河路 6 号（100044）
网　　址：http://www.centuryoriental.com.cn
印　　刷：北京世艺印刷有限公司
开　　本：178 × 226
印　　张：4
字　　数：76 千字
版　　次：2005 年 1 月第 1 版，2005 年 1 月第 1 次印刷
书　　号：ISBN 7-5083-2679-2
定　　价：10.90 元

Contents 目录

Editor's Message 编辑手记

在北京的酷暑中编这本《寒冷的科学》，书中冰天雪地的世界格外引人神往。

一说到寒冷，就会让人想到冰。地球上究竟有多少冰？冰又有多少种名字？有没有“热”的冰？还有雪花，那冰凉、精巧、独特的雪花，它们到底有多少种形状？这种“昙花一现”的娇贵一族，可以被记录被再现吗？还有冰雪的亲戚——雨，雨滴有多大？它们可以被测量吗？还有，地球上到底哪里是最冷的？那些冷得不可思议的冰冻王国里有没有生命？如果有，它们又会是什么样？它们如何在冰冻世界里生存？

还有……

带上你的风雪大衣，向极地出发，让我们到地球上最寒冷的地方凉爽一番。

Glaciers:

冰河：奇妙的时间冰冻机器

by Ellen Butts and Joyce Schwartz

When you drink a glass of water or take a shower, think of glaciers. Why?

Glaciers contain at least 75 percent of Earth's fresh water – much more than all our planet's lakes and rivers combined. If you're flying in a plane on a summer day and see ice glistening below, think of glaciers. Why? They're so large and thick that they stay frozen all year round. And next time you're eager for a time-travel adventure, think of glaciers. Why? Ice cores drilled from glaciers allow scientists to peer back into Earth's past.

A thick mass of slow-moving ice that has formed on land is called a *glacier*. *Ice sheets* are the vast glaciers that sprawl over the entire continent of Antarctica and the island of Greenland. The latter's ice sheet is only the size of Mexico, but Antarctica's is twice as big as the continent of Australia and has been accumulating snow and ice for at least 40 million years! Together, they contain more than 99 percent of Earth's ice.

当你喝水或冲淋浴的时候，想一想冰河（或冰川）。为什么？

冰河包含了地球上至少75%的淡水，远远超过了我们星球上所有河流湖泊的总和。假如你在夏天坐飞机的时候看到下面有冰在闪耀，想一想冰河。为什么？它们又大又厚，终年冰冻着矗立在那里。下次当你期待一次时间旅行的探险时，想一想冰河。为什么？从冰河中采集的冰芯可以把科学家带回到地球的过去。

在陆地上形成的缓慢移动的大块冰被称作“冰河”。“冰原”是覆盖整个南极洲和格陵兰岛的大型冰河。格陵兰岛的冰原只有墨西哥那么大，而南极洲的冰原则有两个澳大利亚那么大，而且那些冰雪已经积累了至少四千万年！两者合在一起所含的冰量超过了整个地球冰量的99%。

Incredible Frozen Time Machines

SLIP-SLIDING AWAY

Glaciers form by the accumulation, compression, and recrystallization of snow. They require very specific conditions of climate and geography, which means that they are found in polar or high mountain regions where snowfall is heavy in winter, temperatures stay below freezing for long periods, and summers are cool. Freshly fallen snowflakes are light and fluffy, but as new layers of snow fall, their weight compresses the snow underneath into small, dense grains that grow to be the size of rock salt. Scientists call these enlarged crystals firn. Firn contains many air bubbles, but over thousands or millions of years the individual grains of firn enlarge, the pockets of air are closed off, and the firn is compressed into slabs of deep glacier ice.

"Hot" ice! Is that possible? Actually, ice is one of the hottest solids in existence, because it's close to its melting point. Glaciers are always moving, but because ice is "hot," they move like liquids rather than solids. Glaciers slide and "creep." They slide over the ground on meltwater, a very thin layer of water from melted ice, and "creep" when their icy layers glide over one another because of their weight. Different parts of the same glacier slide or creep at different speeds. The center moves more rapidly than the sides; the surface moves more rapidly than the bottom, because the sides and bottom are restricted by friction. Most glaciers move several feet per year, while others "race" a few miles.

Glaciers carry, grind, or crush everything in their

滑行移动

冰河是由冰雪的积累、挤压和再结晶而形成的。它们需要特定的气候和地理条件；这意味着它们会出现在极地或高山地区，因为那里冬天的降雪量很大、气温长时间保持在摄氏零度以下，而且那里夏天也十分凉爽。新鲜的降雪是轻柔而松软的，但是新降落雪层的重量会将它们挤压成小而密的细粒，这些细粒将会逐渐变成岩盐的大小。科学家称这些变大的晶体为“粒雪”。“粒雪”包含了许多气泡；但是经过数千年甚至数百万年后，单个“粒雪”的细粒变大，其中的空气泡被隔离了；于是“粒雪”被挤压成冰河。

“热”雪！这可能吗？事实上，冰是现实中存在的最热的固体之一，因为它接近于它的融点。冰河是不停移动的，但是因为冰是“热”的，所以它们移动的形态更像液体而非固体。冰河滑行着，“蠕动”着。它们在地面上薄薄的一层冰雪融水上滑动；而当冰层滑过时，由于彼此的重量这种移动又变成了“蠕动”。同一冰河的不同部分以不同的速度滑动或“蠕动”。中心部分比四周移动得更快，而表面比底部移动得更快，因为四周和底部受到摩擦力的限制。大多数冰河每年移动几英尺，而有的冰河则要“冲刺”几英里。

path – huge rocks, forests, and hills. As rocks are carried, they are broken down into smaller and smaller pieces. Sometimes rock fragments are left behind in piles called *moraines*. Glaciers even reshape mountains, leaving pointed peaks and jagged ridges. Wherever they slowly sweep Earth's surface, they completely remodel the landscape.

冰河带走或碾碎挡在其途中的任何东西，比如大石块、森林和山丘。当岩石被冰河带走的时候，它们破碎为小块。有时岩石的碎片被遗落下来形成一堆堆的“冰碛石”。冰河甚至会重塑山脉的形状，留下突出的山峰和锯齿状的山脊。它们缓慢滑行所经过的地球表面，处处都留下它们的痕迹，沿途的地形风貌随之而改变。

ICE CORES AND GLOBAL CLIMATE CHANGE

Far below a glacier's surface, information about Earth's history and climate is locked away in layers of ice. Ice cores are the key to this treasure. They are cylinders of ice about 12 centimeters (4 to 5 inches) in diameter that are extracted from glaciers with a drill. By dating cores from around the world and studying the gases and other contaminants trapped in them, *glaciologists* have been able to create a picture of global climates reaching back over 100,000 years. The more we understand about past climate changes, the better we'll be at predicting future ones.

Glaciologist
Scientist who studies how glaciers flow, and how they interact with the atmosphere, ocean, and land

Glaciers grow by adding a new layer of snow each year. It's easy for scientists to see the annual layers in an ice core by lighting it from beneath. They can then count the layers to determine the age of any section, much like you can count tree rings to determine a tree's age.

Dr. Richard Alley, an expert on glaciers and climate, spent five summers removing a 3,000-meter-long (2-mile) core from the Greenland Ice Sheet. Because it was impossible to remove it in one piece, his team drilled out the core in 1-meter (3-foot) segments. Annual layers in the Greenland ice core are clearly defined back to depths dating to 50,000 years ago, but deeper layers have been thinned and deformed by the

冰芯和全球气候变化

在层层冰雪包裹的冰河的表面之下，隐藏着有关地球历史和气候的信息。冰芯则是探寻这一宝藏的钥匙。它们是直径约为12厘米（4～5英寸）的圆柱形的冰柱，是用钻机从冰河中采掘而出的。通过将世界各地的冰芯注明日期并研究它们所包含的气体和其他污染物，冰河学家制作了十万年前的全球气候图。我们对过去的气候情况了解得越多，那么我们就可以更好地预测未来的天气情况。

每年新的雪层的覆盖促成了冰河的不断生长。用光照射冰芯的底部，科学家就可以轻易地看到每年的冰层。通过计算冰层的数量可了解冰河任何一部分的年龄，就好比人们可以通过数年轮来了解树木的年龄。

冰河及气候专家理查德·艾里博士花了五个夏天的时间将一个长达3000米（两英里）的冰芯从格陵兰岛的冰原上取回。显然，想要将它完整地取回是不可能的，于是他的团队将冰芯一段一段地钻出，每一段的长度为1米（3英尺）。格陵兰岛冰芯所显示的冰层可以追溯到五万年前，但是由于冰河的流动，更深处的冰层已经变薄或已经变形。像艾里博士这么有经验的冰河学家知道如何解释那些有问题

glacier's flow. An experienced glaciologist like Dr. Alley knows how to interpret the problem layers and can get an accurate count as far back as 100,000 years.

Glaciologists check their count of the layers by testing them for contaminants from volcanic eruptions and other catastrophic events whose dates are known. For example, finding volcanic ash from the eruption of Mt. St. Helens in 1980 in the right layer means that it has been correctly counted and dated.

After dating the cores, scientists look for evidence of climate change frozen in the ice. Anything that can be carried by the wind (dust from faraway deserts, salt from the ocean, and pollen, for example) has been found in ice cores. Each of these substances provides a clue to past climates. Increasing amounts of dust and ocean salt in a series of layers signal a cooler, dryer climate. The amount of pollen from warm-weather plants compared to the amount from cold-weather plants in a layer also helps scientists figure out what the global climate was like in the past.

Carbon dioxide gas has also been found trapped in bubbles inside ice cores. (You may be familiar with it as the greenhouse gas that comes from burning fossil fuels like oil and coal.) Although no one is sure whether increased amounts of Carbon dioxide cause global warming, glaciologists have found that warm climates and larger amounts of Carbon dioxide go together.

From their work on ice cores, glaciologists know that the history of Earth's climate is one of constant change. For the past 10,000 years, the global climate has been unusually stable, but in the last few decades, average temperatures have risen to their highest levels in over 100 years. Scientists are concerned that human activity may push the climate into another period of drastic change. They hope to use what they've learned from ice cores to help us understand how climate works and avoid upsetting its delicate balance.

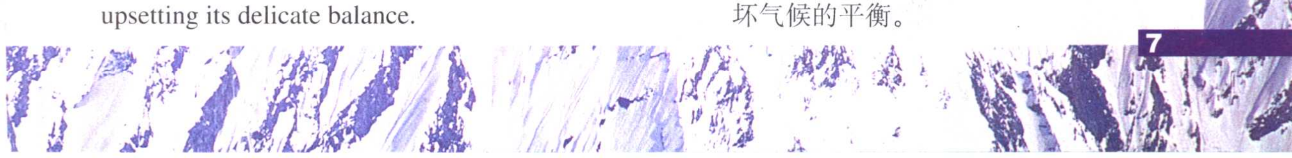
的冰层，并且仍然能够根据冰层的数量追溯到十万年前。

冰河学家通过检验冰芯中那些来自已知年代的火山爆发和其他灾难事件的污染物来确认冰层的年代。例如，在相应的冰层中发现了1980年圣海伦斯火山爆发的火山灰，证明该冰层所记录的年代是正确的。

在注明冰芯所显示的不同年代之后，科学家开始寻找冰中冻结的气候变化的证据。任何可能被风带走的物体（如来自遥远沙漠的灰土、海洋中的盐分以及花粉）都能在冰芯中找到。这些物体中的每一种都能为过去的气候状况提供线索。在一系列冰层中增加的灰尘和海盐的数量代表了一个更为寒冷和干燥的气候。冰层中温带气候植物的花粉数量和寒带气候植物的花粉数量的比较也可以帮助科学家了解过去的全球气候状况。

二氧化碳也被发现存在于冰芯中的气泡里。（你或许对它作为石油和煤等矿物燃料燃烧后产生的温室气体的情况较为熟悉。）虽然没有人能确定增加的二氧化碳是否确实带来了全球变暖，但是冰河学家却发现温暖的气候与大量的二氧化碳是同时存在的。

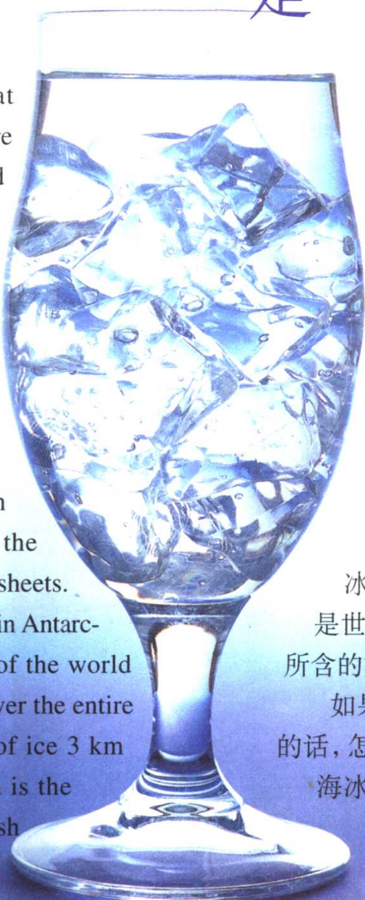
通过对冰芯的研究，冰河学家发现地球气候的历史是一个不断变化的过程。在过去的一万年中，全球气候一直是非常地稳定的，但是在最近的几十年中，平均气温上升到近一百年的最高水平。科学家担心人类活动会使气候进入另一个巨变时期。他们希望利用他们从冰芯的研究中所了解到的来帮助我们理解气候是如何变化的，以及如何避免破坏气候的平衡。



How Much Ice is There?

地球上有多少冰？

by Don Perovich and Jackie Richter-Menge



OK, we know that there is sea ice in the polar oceans and glaciers scattered in mountains around the world, and that Greenland and Antarctica are almost completely covered with ice. But how much ice is there? The table below shows the volume of each type of ice and how much the sea level would rise if the ice melted. Even though there are over 150,000 glaciers, the volume of ice contained in them is small compared to the Greenland and Antarctic ice sheets. There is a huge amount of ice in Antarctic – more than in the rest of the world combined, and enough to cover the entire United States with a layer of ice 3 km thick. The ice in Antarctica is the largest potential source of fresh

是的，据我们所知，在极地的海洋中有海冰，在世界各地的山脉上散布着冰川，而格陵兰岛和南极几乎完全被冰雪所覆盖；但是，地球上究竟有多少冰呢？下面的表格显示了各种冰的体积，以及假如这些冰融化的话，海平面可能会升高的高度。虽然大约有超过150 000个冰川，但是与格陵兰岛和南极的冰原相比，它们所包含的冰的体积仍然十分小。在南极洲有大量的冰，它们甚至超过世界其余地方的冰的总和；那里的冰可以覆盖整个美国，且冰层厚度可达3000米。南极洲的冰是世界上最大的潜在淡水源。南极冰所含的淡水量是五大湖的1000倍。

如果这些冰由于全球变暖而融化了的话，怎么办呢？有趣的是，如果所有的海冰融化的话，那么海平面增加的高度为零。为什么会这样呢？因为

water in the world. There is 1,000 times more fresh water in Antarctic ice than in the Great Lakes.

What if this ice melted due to global warming? Interestingly, if all the sea ice melts, the total rise in sea level will be zero. Why? Because the sea ice is already floating.

Try this experiment: Put some ice in a glass, and then very carefully fill the glass to the top with water. The ice in the glass is floating. As the ice melts, does the glass overflow?

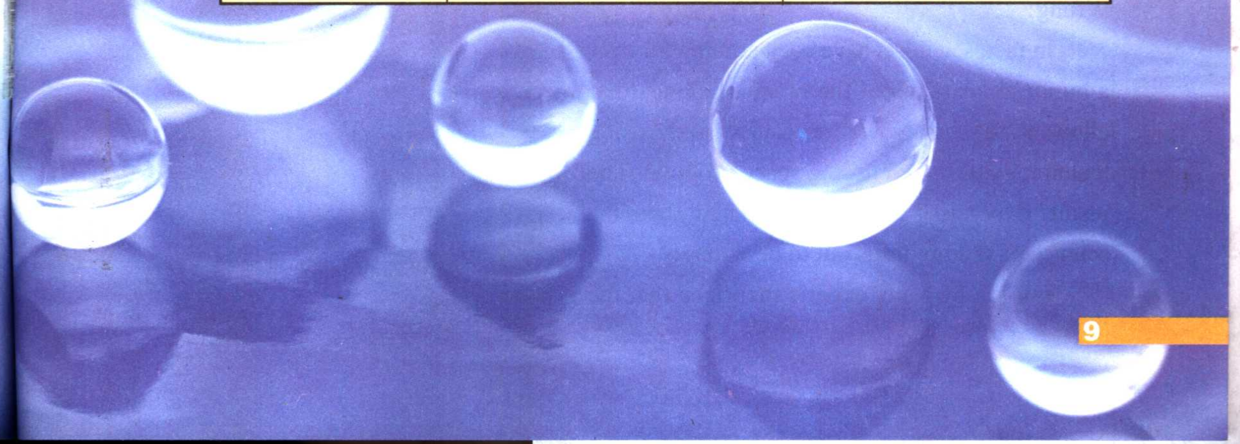
Most of the ice in glaciers, in Greenland, and in Antarctica is sitting on land and not floating. Melting this ice would cause a large rise in sea level – of some 80 meters, in fact. Luckily, Greenland and Antarctica are so cold that most of the ice won't melt even with global warming. However, with global warming there could be more melting around the edges, and possibly large pieces of the Antarctic ice sheet might break off into the ocean. If this happened, the sea level could rise by as much as five meters.

海冰本来就是漂浮在海面上的。

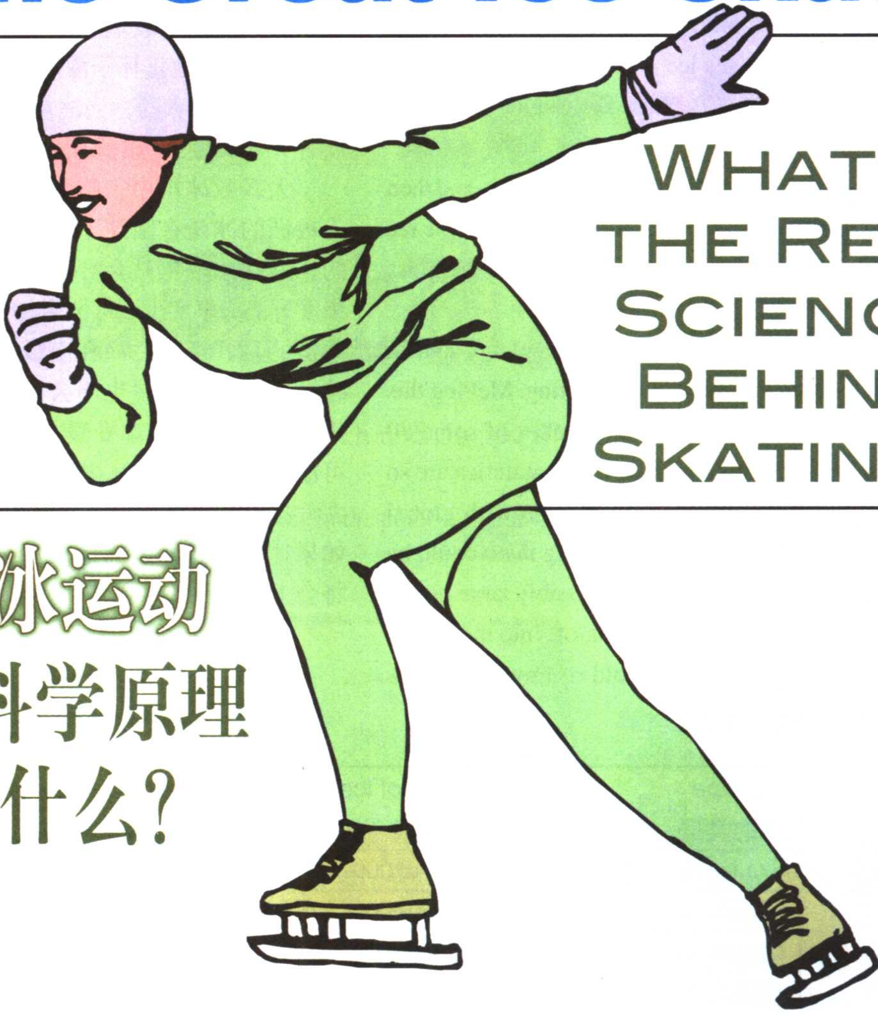
假如你不相信的话，可以来做个小试验：在一个玻璃杯中放入一些冰块，然后小心地将杯子灌满。玻璃杯中的冰块是漂浮着的。当冰融化后，玻璃杯中的水会溢出来吗?

大多数冰川中、格陵兰岛上以及南极洲的冰是在陆地上的，而非漂浮的。这些冰融化就会导致海平面的大幅度升高，事实上，可能会增高80米。幸运的是，格陵兰岛和南极洲极度寒冷，即使全球变暖也不会使这些冰融化。然而，随着全球变暖，在边缘地区可能会出现更多的冰融现象；南极洲大片冰原甚至可能断裂并落入海洋中。如果这种情况发生的话，那么海平面将会上升大约5米之多。

Ice type 冰的类型	Volume of ice (km^3) 冰的体积（立方千米）	Sea level rise (m) 海平面上升高度（米）
Sea ice 海冰	40 000	0
Glaciers 冰川	180 000	0.45
Greenland 格陵兰岛冰原	2 620 000	6.55
Antarctica 南极洲冰原	30 109 800	73.44



The Great Ice-Skating



WHAT'S THE REAL SCIENCE BEHIND SKATING?

溜冰运动的科学原理是什么？

Skating is a simple activity. So the science behind the sport must be simple, too, right? Wrong!

In fact, scientists have been arguing for over a hundred years about the precise science that allows us to skate. Now there's a new study, using technology designed for the space program. The result? Everything we thought we knew about the science of skating turns out to be wrong!

For a long time, experts theorized that the

溜冰是一种简单的运动，因此这项运动背后的科学原理也必定很简单，对吗？那你想错了！

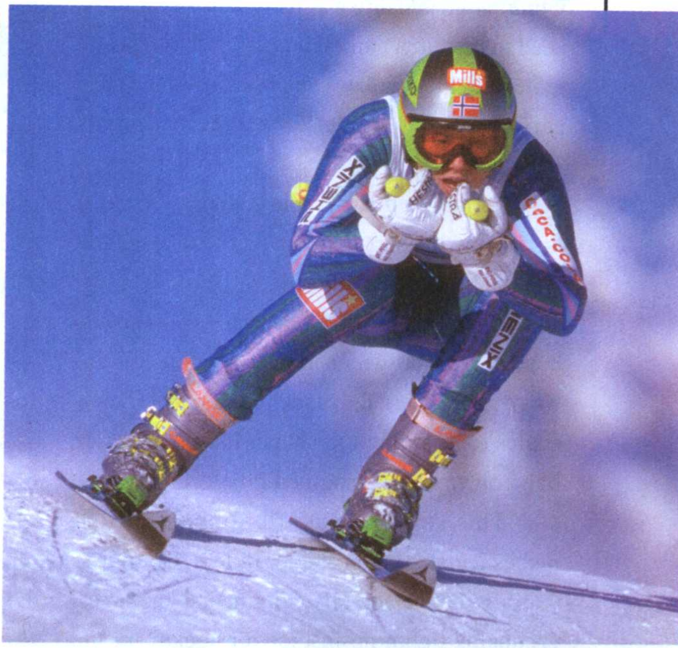
事实上，关于溜冰的科学原理，科学家们争论了一百多年。现在，一种新的研究正在进行，使用的是为太空项目所设计的技术。结果呢？我们先前所了解的所有关于溜冰的学问原来都是错的！

很长时间以来，专家们的理论认为溜冰的关键是压力。或许在冰刀上平衡着的溜冰者

Competition!

by Nick D'Alto

激烈的滑冰竞赛



key to skating was pressure. Maybe the weight of the skater balancing on those thin blades produced enough pressure to melt the ice – leaving a thin film of water that helped the skater slide. True? Well, ice really does melt when it's placed under enough pressure – even when its temperature is below 0 degrees C (32 degrees F).

But then someone finally measured the pressure between a skate blade and the ice. It wasn't nearly enough to produce melting. So despite being quoted since the 1800s (and still appearing in some of today's science books), the "pressure" theory about ice-skating turns out to be wrong.

Another theory about skating involves friction. Like rubbing your hands together, friction can generate heat from motion. Does friction help a skater melt the ice?

Well, get ready for skating's newest spin. Seems that friction and even pressure do help us skate, in some ways. But the real secret behind skating is only discovered using the remarkable science of surface physics. That science is unlocking an amazing new world within ice, which exists only in the molecules right at the surface.

When scientists at Lawrence Berkeley Na-

的重量产生了足以使冰融化的压力，并在冰面上留下了薄薄的一层水，使溜冰者能够滑动。这是真的吗？确实，当对冰施加足够的压力时，冰确实会融化；甚至当它的温度低于0℃（32°F）时，这种情况也会发生。

但是，有人最终测量了冰刀和冰面之间的压力，却发现它并不足以导致融化现象。因此，虽然这种关于溜冰的“压力”理论从19世纪开始就被人们频繁地引用(即使在今天仍出现在一些科学书籍上)，但是事实证明它是错误的。

关于溜冰的另一个理论牵涉到摩擦。就好像通过摩擦双手的运动就可以产生热量。摩擦是否会帮助溜冰者融化冰面呢？

tional Laboratory trained high-tech instruments on this incredibly thin slice of the cold stuff, they encountered a bizarre new ice region. They call it "the quasi-fluid layer." Compared to ordinary ice, half the molecules in the quasi-fluid layer appear to vanish. Actually, they're vibrating up and down at incredible speeds. No need to melt it; a natural quasi-fluid layer just a molecule thick makes even rock-solid ice slippery – even at minus 200 degrees C (minus 392 degrees F).

Forming a microscopic boundary between the ice and the surrounding air, this quasi-fluid layer is literally "on the edge." Here, ice crystals "crush" inward from the force of a skater's blades. Normal water molecules deform into weird geometries; they lack "neighboring" molecules to hold them in shape. It's ordinary ice like you've never imagined it before.

This strange quasi-fluid layer is what makes ice-skating possible. In fact, heating or cooling the ice actually "engineers" the layer, producing lightning-fast ice for hockey, or the more "precise" ice that figure skaters use to win the gold.

With this new knowledge, the science of skating is changing at Olympic speed. No surprise; scientists are always challenging old theories so that they can discover new and more accurate explanations about our world. It's like knocking down a snowman so that you can build an even better one.

Turns out that skating is easy – but it takes high-tech science to really understand how it's done. Next time you head for the rink or the pond, think about the quasi-fluid layer. It helps you skate because it's "on the edge."

那么准备好来看看关于溜冰的最新理论吧。看起来摩擦力或压力确实能够在某些情况下帮助我们溜冰。但是，只有在运用了卓越的表面物理学之后，人们才发现了溜冰的真正奥秘。这一奥秘为人们打开了一个崭新的关于冰的神奇世界，事实上，溜冰背后隐藏的学问就存在于那些冰面的分子中。

当劳伦斯·伯克利国家实验室的科学家使用高科技设备研究这一超薄的冰面时，他们遭遇了一个奇异的新的冰区。他们称其为“半液态层”。和普通的冰相比，“半液态层”中的半数分子看来都消失了。事实上，它们是以一种令人难以置信的速度在上下振荡。并不需要让冰融化；即使在−200℃（−392°F）仅有一个分子那么厚的自然“半液态层”也能使岩石般坚硬的冰变得很滑。

确切地说，“半液态层”处在“边缘上”，在冰和周围的空气之间形成了一个精微的边界。在这里，溜冰者冰刀的力量使冰晶被压碎。正常的水分子变形成为怪异的几何形状；同时缺少邻近的分子支撑它们的形状。这是你所从未想象过的正常的冰。

奇怪的“半液态层”是使溜冰成为可能的关键。事实上，加热或冷却冰面改变了“半液态层”，产生了曲棍球运动所必需的“超快速”冰面或者使溜冰者获取金牌的冰面。

有了这样的新知识，溜冰的学问以奥林匹克的速度发生变化。这并不奇怪；科学家们总是不断地挑战旧的理论，这样他们才能够对我们的世界作出更新更准确的解释。这就好像只有拆毁原来的雪人，才能够建造更好的雪人一样。

表面上看起来溜冰似乎很简单，但却需要借助高科技才能够真正理解它到底是怎么回事。下次当你再去溜冰场或冰冻的池塘的时候，记得想一想“半液态层”。它之所以可以帮助你溜冰，是因为它处在“边缘上”。

Why Does Ice Float?

by Don Perovich and Jackie Richter-Menge

冰为什么会漂浮？

Well, for starters, if water were like most other natural substances on Earth, you'd have to wear scuba diving equipment to go skating on a lake. That's because the ice would be on the bottom of the lake, not the top.

Here are the facts. Most substances, when they change from a liquid to a solid, become denser. This means that if you weighed an equal amount of the liquid and the solid, the solid would be heavier. Guess what happens when you put the solid into the liquid? It sinks.

But not water! When water turns from a liquid to a solid, or freezes, it becomes LESS dense and, you've got it. . .it FLOATS!

Basically, it all boils down to (or should we say, "freezes up to"!) the property called density. The density of a substance is related to how much it weighs divided by its volume, or amount. If you are comparing the same volume of different substances, then the higher the weight, the higher the density.

Still wondering? Try this: Take a container, fill it with vegetable oil, and weigh it. Take an identical container, fill it with water to the exact same level, and weigh it. You should find that the container of oil is lighter than the container of water. Since the same volume of oil and water has been weighed, this means that the oil is less dense than the water. Now, mix some of the oil and water. Voilà! The oil FLOATS, just like ice on water.

对于初学者，如果水像地球上其他大多数自然物质一样，那么你会穿戴着水中呼吸器和潜水设备到湖中溜冰。这是因为冰会沉在湖底，而不是漂浮在水面。

事实情况是，大多数物质在从液态转变到固态的时候，密度会变得更大。这意味着，如果你称相同量的液体和固体，那么固体会更加重。当你把固体放入液体中的时候，猜猜会发生什么事情呢？它会沉下去。

但是水却不是这样的！当水从液态变为固态，或者说结冰的时候，它的密度变得更小。对，它会漂浮起来！

基本上来说，这都归结为“密度”这一特性。一种物质的密度与其重量（质量）除以其体积所得值相关。如果你比较不同的物质，那么当体积相同时，重量（质量）越大，密度就越高。

还想不明白吗？那么试试这个：找一个容器，将它装满菜油，然后称一下它的重量。拿一个完全相同的容器，将它装满相同量的水，然后称一下它的重量。你将会发现，装油的容器比装水的容器要轻。由于相同量的水和油都被称过了，这意味着，油的密度比水的密度小。现在，将一些油和水混合。哇！油漂浮在水面上，就好像冰漂浮在水面上一样。

Life Bel

零度以下的生命

Moving through the deep snows of the highest mountains and the tangled tunnels of sea ice, or waiting deep inside the ice of *permafrost*, ancient glaciers, and polar lakes, small organisms carry on their secret lives!

On a snapshot of Earth from space, the tremendous expanses of frozen whiteness stand out frigid and *lifeless*. But not so quick! Scientists everywhere are bundling off to

Permafrost
Permanently frozen subsoil, occurring throughout the polar regions and other regions that remain permanently cold

在高山的深层积雪和交错的海冰隧道中穿行，或者等待在永久冻土层、远古冰河和极地湖泊的冰层中，许多不为人知的微小生物在那里生活着。

在一张从宇宙拍摄的地球快照中，大片冰冻的白色看起来是那么的呆板和缺乏生机。但是别这么快就下定论！世界各地的科学家都匆匆赶到地球上最寒冷

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