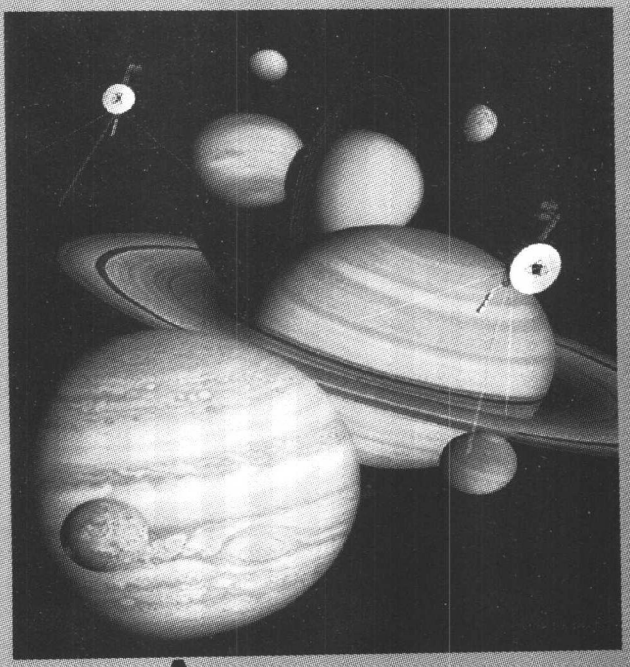
Part One



Astronomy

天 文

Stardust

星尘

This special issue of The Sciences, The Frontiers of Life, began its own life when Davide S. McKay and his coworkers announced that they had evidence for ancient life on Mars. The early details **conveyed** the credibility of the announcement: the suspects were microorganisms, not **little green men**, and the source was a team of respected investigators writing in the peer-reviewed journal Science. One is exceedingly **wary about** claims for **extraterrestrial life**, of course; the history of the subject is replete with wishful thinking masquerading as **tough-minded** empirical science. But here at last, it seemed, was a claim that **had the ring of truth**: A meteorite, certifiably from Mars, carried the chemical signature of what could be the by-products of Martian **metabolisms**. Furthermore, as all the world could see, within that four-pound rock from Mars were **microscopic** rodlike objects that seemed to be the fossilized remains of extremely simple bacteria. No question: We at *The Sciences* owed you, our readers, an account of the matter that went **substantially** beyond the scope of a single article.

As we began to gather material, though, the life-on-Mars hy-

pothesis was **flagging** under the rigors of continued scientific scrutiny. The evidence cited by McKay et al. was admittedly **circumstantial** from the start. But McKay had argued that, taken as a whole, his evidence pointed strongly toward a biological origin. Today, however, a **consensus** seems to be building that the reverse is true: the various clues add up not to animal or vegetable, but mineral.

Was our story dead? On the contrary. According to the buzz at the annual meeting of the American Association for the Advancement of Science, held fully six months after the announcement, the Martian meteorite debate was having a **galvanizing** effect on a broad spectrum of scientific initiatives. At **NASA**, planned missions to Mars had acquired new urgency. Students of the earth's mid-ocean ridge were closely following the incoming data from the **Galileo** mission to Jupiter, looking for more hints that an ocean of water-and with it, undersea volcanoes-could exist under the ice that covers **Jupiter's** moon Europa. Future interplanetary missions to Europa and other promising sites seemed far more likely to find support than they had before McKay's announcement. In short, for the fist time in many years there was widespread and genuine willingness to commit funds and reputations to exploring a range of issues related to the search for extraterrestrial life.

We, too, decided not to focus on Mars alone, and instead to expand our coverage to a much wider **canvas**. And once we did, we found a remarkable body of new evidence emerging from **disparate** disciplines that was **pertinent to** the questions raised by McKay. Biological interest in genetic self-repair led investigators to **sequence** the genome of the **radiation-tolerant** bacterium Demococcus Radiodurans. That work constitutes an important step in understanding

an **ingenious** biological mechanism that might enable an organism to survive a long ride through space on a meteoroid. The **serendipitous** discovery of bacterial blooms following undersea volcanic eruptions led **oceanographers** to suggest that life might have originated on the seafloor, where it would have been protected from the lethal **ultraviolet radiation** and meteorites that bombarded the surface of the early earth. The U. S. Department of Energy, in its effort to clean up **toxic** chemicals, drilled deep into the earth's crust to prove that bacteria could live there and, perhaps, be trained to digest chemical contaminants. Weapons testing with high-speed **projectiles** helped prove that material exchange between the planets is not so limited as had once been thought: in fact, some 500 kilograms of rock from Mars are estimated to land on the earth each year. Finally, as Laurence A. Marschall reports in *Planetary Prospecting*, a clever program to hunt for periodic changes in the spectra of stars has confirmed the existence of numerous giant planets orbiting stars beyond our solar system.

And so, to the question: Is there life beyond the earth? **The jury**, of course, **is still out**. But with planets aplenty; with creatures that can live without the energy of a nearby star; with abundant cosmic sources of hydrogen and oxygen to make water; with several natural ways for planets to generate internal heat; with the possibility that life could originate in undersea volcanoes and propagate varieties hardy enough to spread their seeds to other worlds; and with rocky meteorites that could serve as vehicles for interplanetary exchange, the idea that life has evolved elsewhere in the universe seems less daunting than it did just a few years ago. The singer and songwriter Joni Mitchell had it right, when she wrote years ago:

We are stardust
(Billion-year-old carbon)
We are **golden** …
And we've got to get ourselves
Back to the garden.
(Peter G. Brown)

Words & Expressions

1. convey *v.* 传播,传递
2. little green man *phr.* (假想的)外星人
3. wary about *adj.* 谨防的,唯恐的
4. extraterrestrial life *phr.* 地外生命
5. tough-minded *adj.* 意志坚强的,讲究实际的
6. have the ring of (truth) *phr.* (在听者耳中激起的特有声音效果)听起来很真实
7. meteorite *n.* 陨石,流星
8. Martian *n.* 火星的
9. metabolism *n* 新陈代谢
10. microscopic *adj.* 微观的,极小的
11. substantially *adv.* 实质地,本质地
12. flag *v.* 衰退,低落,失去吸引力
13. circumstantial *adj* 与条件有关的,依环境而定的
14. consensus *n.* 意见一致,舆论一致
15. galvanize *v.* 刺激 使振奋,激动
16. NASA *n.* National Aeronautics and Space Administration 国家航空和宇宙航行局(美国)
17. Galileo 伽利略
18. Jupiter *n.* 木星
19. canvas *n* 画面,背景

20. disparate *adj.* 根本不同的,异类的
21. pertinent to *phr.* 与…有关的
22. sequence *v.* 把…按顺序排好，确定…的化学结构序列
23. radiation-tolerant *adj.* 抗射线的，耐辐射的
24. ingenious *adj* 制作精巧的，巧妙的
25. serendipitous *adj.* 偶然发现的，意外得到的
26. oceanographer *n.* 海洋学家
27. ultraviolet radiation *n.* 紫外线
28. toxic *adj.* 有毒的
29. projectile *n.* 抛射体，弹射体
30. The jury is still out. 暗指事物不能确定（断定）
31. golden *adj.* 金光烂烂的，朝气蓬勃的，前途光明的

《科学》杂志的专刊《生命前沿》发行时戴卫斯·马凯和他的同事宣布已经掌握了火星上有古代生命的证据。从初步公布的情况来看此说有其可信性：他们只是怀疑火星上有微生物，而不是有什么小绿人。况且消息来自一组受人尊敬的研究人员发表在同行阅读的《科学》杂志上面。当然，人们总是对地外生命的说法持特别警惕的态度，过去一提到地外生命，人们就充满痴心与妄想，这个提法总是以讲究实际的实验科学的面目出现。现在终于有了听起来相当真实的说法：现已证实来自火星的一块陨石携带着一种化学物质，它们可能反映出火星上生命新陈代谢的某些特微。世所共知，在那四磅重的陨石内部有微小的条形物质，可能是极原始的细菌化石。毫无疑问，我们《科学》杂志应用远比这篇文章更多的篇幅对这件事做出分析和解释。

当我们开始收集资料时，火星上有生命这一假设正在经受科学界不断的严格审查。马凯等人引用的证据从一开始就被公认为是很难断定。但是马凯说从整体情况来看，他的证据明显表示陨

石上的物质属于生物。然而今天舆论趋于一致，认为相反的意见是正确的 各种线索加起来说明此物质既不属于动物,也不属于植物,而是属于矿物。

难道我们的故事就此结束了吗？正相反，在马凯的判断公布整整二个月之后，美国科学发展协会年会上传来的信息说有关火星陨石的辩论引起了一系列科学议题的提出。对美国国家宇航局来说火星登陆计划更显得特别紧迫。研究地球大洋洋底形成的海脊的学者也在密切注视探索木星的伽利略号飞船传回的最新信息：在木星的卫星欧罗巴表面冰盖下面是否存在着海洋及海底火山的迹象，将来飞往欧罗巴及其他可能有生命的地点的星际航行任务可能会带来更多的新发现，支持地外生命这一假设。总之，多年来，第一次有更多的人真诚地希望对探索地外生命诸问题，应拨出更多的资金，给予更多的重视。

我们还决定不要只关注火星的生命现象，而要在更大的范围内进行研究探索。这样一来，我们便发现了数量惊人的新证据，他们分别来自与马凯假设有关的不同学科领域。生物界对基因自我修补的兴趣使探索者对耐放射线的细菌（*Deinococcus radiodurans*）的基因组的排列顺序进行了研究，这有助于理解小行星上有机物精妙的生理机制，这种机制能使它们在宇宙中长途跋涉后仍能生存下来。海底火山喷发后会有大量细菌滋生，因此，海洋学家提出生命可能来自海洋底部，那里可以保护生命免遭致命紫外线的辐射和小行星撞击地球表面带来的致命危险。美国能源部一直致力于清除有毒的化学物质。他们曾钻探到地壳深处，试图证明细胞有能力在那里生存，也许还能吞噬掉化学污染物。武器实验中发射的高速射弹也有助于证明行星际的物质交换并不像以前认为的那样有限 事实上,每年约有 500 公斤火星岩石溅落到地球上。最后,正如劳伦斯·玛舍尔在《行星勘探》一书中所说,一个搜寻恒星光谱周期变化的聪明计划证实在太阳系之外有无数个大行星围绕

着恒星在做轨道运行。

所以，地球之外有生命存在吗？对这个问题目前还难以确定。然而空间行星多不可数；有些生物可以在没有恒星提供能量的地方生存；太空中有大量氧和氢，这些太空资源可以合成水；相当数量的行星内部存在着天然的热能；海底火山附近可能有生命存在，他们种类多，大量繁殖而且很难发展到其它地方繁殖，生长；陨石可能就是行星际物质交换的一个载体。考虑到以上因素，生命由宇宙中其它地方进化而来的想法就不会那么令人咋舌了。歌手及词作者约尼·米歇尔说得好，她在几年前写的歌词中说：

我们是宇宙中的尘埃，
我们是有几十亿年龄的碳。
我们朝气蓬勃，金光灿灿……
我们要设法回到那乐园。

2 The Snows of Mars

火星上的雪

Mars holds a special place in the human imagination as the planet most like the Earth. It has an atmosphere, seasons, and distinctive polar ice caps. The ice caps, first observed by Giovanni Cassini in 1666, immediately raised **tantalizing** questions. Are they made of water ice like the giant glaciers that **smother** Antarctica? Are they the frozen remains of long-vanished oceans? If they melted, could Mars become a habitable place? NASA's Mars Global Surveyor, currently in orbit about the Red Planet, is finally providing some final answers.

The Surveyor has already revealed unexpected details about the size and structure of Mars's northern cap. The spacecraft will begin mapping, for the first time, the **topography** and composition of the even more poorly understood southern polar ice cap. The new information will strip away many of the lingering mysteries of the Martian poles.

On Mars, the presence of water — essential for life, past or present — is always an issue of great interest. "Some people have proposed that there were oceans early in Martian history; others

have said there were not. And all sorts of climatic cycles have been proposed," says geophysicist Maria Zuber of MIT. "But for all of those theories, one needs to understand the water cycle: how much water there was, where it went to, and where it's at now." If scientists find substantial reserves of frozen water, it would **bolster** the view that Mars was once a balmy, moist world where life could have started.

Until about two months ago, planetary astronomers believed that the southern cap contained nothing but frozen carbon dioxide, also known as dry ice. New research suggests otherwise: a thick sheet of carbon dioxide ice would be too soft to stay stable. "The thought now is that carbon dioxide ice is so weak that it would flow away, like a glacier, even at very low temperatures," Zuber explains. "So to maintain the topography of the south polar cap, there has to be water ice in there stiffening it up."

Zuber and her colleagues also analyzed Mars's much larger northern polar cap. Using data from the Global Surveyor, the team created maps revealing that the northern pole of Mars is a **bizarre**, rugged place. The ice cap is cut by deep troughs and chasms; some of these **depressions** extend down over a mile to the base of the planet's crust. Their finding, which was published in the ***Science*** and reported at a major press conference at the American Geophysical Union, caught many researchers off guard. "There are no **troughs** of that kind in any of the ice caps on Earth," said Global Surveyor project scientist Arden Albee of Caltech at the **AGU** press conference. "We don't know how this formed." Additional findings from the Global Surveyor, along with a commentary by Zuber, appear in the *Nature*.

Zuber's results confirmed that the northern cap is composed entirely of water ice, in some areas interspersed with layers of windblown dust and **sediment**. That piece of good news came as no surprise, because summer temperatures at the cap are high enough to vaporize frozen carbon dioxide. But the Global Surveyor also produced the first accurate measurement of the size of the northern cap — and that was a surprise.

Seven hundred and fifty miles across, and up to two miles thick, the northern cap has a volume just half that of the Greenland ice sheet. It may sound large, but doesn't contain nearly enough water to account for the flood channels and other erosion features that appear all over the place on Mars. "It's not even close to what is generally believed to have once been on the surface," says Zuber. Scientists like Michael Carr at the U.S. Geological Survey who believe oceans once covered much of Mars face a serious challenge from the Global Surveyor studies. The northern cap contains no more than one tenth the amount of water needed to fill an ancient ocean. On the other hand, the **fissures** and ring of **residual** ice around the **perimeter** of the cap suggest it has lost a great deal of water over the millennia.

The Global Surveyor has also provided some clues about the way water circulated about on Mars in the distant past. The northern ice cap sits nestled within a deep depression that covers essentially the entire northern hemisphere of Mars and drops in elevation as it nears the pole. The cap "looks something like a hockey in that depression," David Smith of NASA's Goddard Space Flight Center reported at the AGU press conference. Researchers are not sure how the giant lowland formed (perhaps through a large impact), but

they do know that it has been there since very early in Martian history, and so has clearly played an important role in the planet's water cycle.

"Before we made these measurements of the northern hemisphere, it used to be thought that the only way you could get water to the north pole of Mars was through the atmosphere," Zuber says. But because the northern cap lies at a lower elevation than the rest of the planet, "water than you put down almost anywhere in the northern hemisphere is going to flow toward the pole."

Clearly, Mars was not always the frozen wasteland it is today. What happened? Some of the ancient water could have been lost to the atmosphere and then, over countless millennia, ejected into space through complicated interactions with the Martian magnetic field. Some might still be locked in **aquifers** and other formations beneath the surface. And some may exist in the southern polar cap — but not much. The southern cap is significantly smaller than the northern one. Even if the Mars Global Surveyor finds water ice in the south, it won't come close to eliminating the water shortage, according to Zuber.

"We haven't either improved or diminished the possibility of life on Mars," she says. "Essentially, what we have done is **exacerbate** the problem of there being too little water on Mars today compared to where there was earlier. Now those people who have proposed oceans have a bigger task in explaining where the water went." (Kathy Svitil)

Words & Expressions

1. tantalizing *adj.* 非常着急的
2. smother *v.* 窒息
3. topography *n.* 地形学
4. bolster *v.* 支持
5. bizarre *adj.* 奇异的(指态度,容貌,款式等)
6. depression *n.* 凹陷；凹陷处
7. trough *n* (与波峰相对的)波谷
8. AGU = American Geophysical Union 美国地球物理协会
9. sediment *n.* 沉淀物,沉积
10. fissure *n.* 裂缝,裂沟
11. residual *adj.* 剩余的，残留的
12. perimeter *n.* 周长，周界
13. aquifer *n.* 含水土层，蓄水层
14. exacerbate *vt.* 恶化,增剧,使加剧

火星作为最像地球的一颗行星，在人类的想象中占有特殊的位置。它也有空气、季节和独特的极地冰冠。1666 年,由乔万尼·卡西尼发现的冰冠立即引发了一些问题：它们也是由像包围着南极洲的巨大的冰川一样的冰水构成的吗？它们是消失已久的海洋冻结的残余吗？如果它们融化的话，火星能够成为一个可以居住的地方吗？最近环绕这颗红色行星轨道运行的 *NASA* 的全球监测机构最终提供了一些可靠的答案。

监测机构已经揭开了关于火星北边冰冠的尺寸和结构的令人意想不到的细节，太空船会首次绘制更加鲜为人知的南边极地冰冠的地形图和构造图。新信息定会揭开萦绕在火星极地之上的迷团。

在火星上，无论过去或现在都作为生命之本的水的存在总是

一个让人非常感兴趣的话题。麻省理工学院的地球物理学者玛利亚·尤伯说“有些人认为在火星的早期历史上有过海洋,而另外有些人认为没有。不过大家都认为存在着所有类型的气候循环。但是,在所有的理论中,人们应该弄清的是水循环曾经有过多少水,流向了哪里,现在在哪里。”如果科学家们能找到大量的冰水的储存,这就可以证明火星是一个有过生命起源的温暖、潮湿的地方。

直到两个月前,行星天文学家们还认为南边的冰冠除了冻结的一氧化碳(也叫干冰)之外,什么也没有。新的研究却表明情况是另外一回事:厚厚一层干冰因为太软,根本无法保持稳定。尤伯解释说“干冰太不稳定,甚至在温度很低的情况下,都会像冰川一样流走。所以要想维持南部冰冠的地形,就必须有冰水使其变得坚固。”

尤伯和她的同事也分析了火星上要大得多的北部极地冰冠。利用由全球监测机构提供的资料,这个小组绘制了一份地图,显示了火星的北极是一个崎岖不平的奇异的地方。冰冠被深深的波谷和坑洞所切开;有些凹陷延伸到火星外壳底部一英里以下。他们的发现发表在《科学》杂志上,在美国地球物理学协会会议上,他们也通过一个大型的记者招待会将他们的发现作了汇报。他们的发现使很多研究人员措手不及。加利福尼亚理工学院的全球监测工程科学家阿登·阿尔比在美国地球物理学协会的记者招待会上说:“在地球的冰冠上没有类似的波谷。我们还真不知道它是如何形成的。”由全球监测机构提供的其它发现连同尤伯的评论一起发表在《自然》杂志上。

尤伯的结论证实了北部冰冠完全是由冰水构成的,某些地区也点缀着由于风吹而堆积的层层的尘埃和沉渣。这条好消息一点也不令人吃惊,因为冰冠的夏季温度高得足以蒸发干冰。全球监测机构还提出了第一种测量北部冰冠大小的方法一这才是令人吃惊的。

北部冰冠有 750 英里宽,两英里厚,体积正好是格陵兰冰原的一半。听起来挺大的，但冰冠的水还不足以覆盖火星上所有地方的水道和侵蚀地貌。尤伯说：“跟人们普遍认为的火星地表曾经有的水量还相差甚远。”像美国地质勘测局的科学家迈克尔·卡尔,他认为海洋覆盖了火星的大部分地区。他的观点现在也面临着来自全球监测机构研究结果的挑战。北部冰冠的含水量只不过是注满一个远古海洋所需水量的 1/10。另一方面，围绕冰冠周围残余冰块的裂缝和环形痕迹也说明了在过去的几千年里火星上失去了大量的水。

全球监测机构还提供了在远古水是如何在火星上循环的线索。北部冰冠位于基本覆盖了整个火星北半球的一个深奥的凹陷处的内部，在接近极地处，海拔下降。*NASA* 的 *Goddard* 太空飞行中心的大卫·史密斯在美国地球物理协会的记者招待会上汇报说：“这个冰冠在那个凹陷处看起来就像一个曲棍球。研究人员也搞不清楚这块巨大的低地是如何形成的（也许是经历了一次大型的冲击），但是他们清楚的是这块低地在火星的早期历史上就存在了,并且在火星的水循环中起着重要作用。”

尤伯说：“在对北半球进行测算之前，我们以为唯一能使北极获得水的方法是通过大气”，但是因为北部冰冠的海拔比火星的其它地方都要低一些;“所以北半球的任何降水都会流向极地。”

很显然，火星曾经并不都是今天这样冰冻的荒原。以前发生过什么？远古的部分水流很可能遗失在大气中了，然后，经历了数千年，通过和火星磁场的复杂相互作用，喷射进大气中。有些水也许还被锁在蓄水层和其它地表以下的构造中。还有些存在于南部极地冰冠中一但不会太多。南部冰冠比北部冰冠要小的多。尤伯认为，即便火星全球监测机构在南部发现了冰水，也不足以消除水缺乏的问题。

尤伯说：“我们既没有增加也没有减小火星上有生命的可能