Running Water on Mars

**火星上的流水**

Photographic evidence suggests that liquid water once existed in great quantity on the surface of Mars. Two types of flow features are seen: runoff channels and outflow channels. Runoff channels are found in the southern highlands. These flow features are extensive systems―sometimes hundreds of kilometers in total length―of interconnecting, twisting channels that seem to merge into larger, wider channels. They bear a strong resemblance to river systems on Earth, and geologists think that they are dried-up beds of long-gone rivers that once carried rainfall on Mars from the mountains down into the valleys. Runoff channels on Mars speak of a time 4 billion years ago (the age of the Martian highlands), when the atmosphere was thicker, the surface warmer, and liquid water widespread.

照片证据显示，在火星的表面曾经存在过大量的液态水。两种流动形式已经被发现：径流沟渠和外流沟渠。径流沟渠发现于南部的高地。这些流动特征有着庞大的系统——有时竟有数百公里长，这些沟渠相互交错、扭转，并可能汇入更大更宽的沟渠中。它们和地球上的河流系统非常相似，地质学家们认为它们是以前曾将火星上的雨水从高山携带到峡谷中的那些河流干涸后的遗迹。火星上的径流沟渠存在于40亿年以前（就是火星高地的年龄），那时候火星的大气层更厚，地表更暖和，并且液态水分布很广。

Outflow channels are probably relics of catastrophic flooding on Mars long ago. ■They appear only in equatorial regions and generally do not form extensive interconnected networks. ■Instead, they are probably the paths taken by huge volumes of water draining from the southern highlands into the northern plains. ■The onrushing water arising from these flash floods likely also formed the odd teardrop-shaped “islands” (resembling the miniature versions seen in the wet sand of our beaches at low tide) that have been found on the plains close to the ends of the outflow channels. ■Judging from the width and depth of the channels, the flow rates must have been truly enormous―perhaps as much as a hundred times greater than the 105 tons per second carried by the great Amazon river. Flooding shaped the outflow channels approximately 3 billion years ago, about the same times as the northern volcanic plains formed.

外流沟渠可能是很久以前火星上洪灾的遗迹。它们只形成于赤道附近，并一般没有形成广泛交错的网络。相反，它们可能是携带大量水从南部高地到北部平原的排水系统。由泛滥的洪水而产生的激流也可能形成奇怪的泪滴状小岛（就像我们在海水低潮时中湿沙地或海滩上看到的微缩版本一样），已经在靠近外流沟渠末尾处的平原上被看到。从这些沟渠的宽度和深度可判断，当时流速一定很大——有可能是亚马逊河每秒钟105吨的流量的一百多倍。大约在30亿年以前，北部火山平原形成的同时，洪水改变了外流沟渠的形状。

Some scientists speculate that Mars may have enjoyed an extended early Period during which rivers, lakes, and perhaps even oceans adorned its surface. A 2003 Mars Global Surveyor image shows what mission specialists think may be a delta―a fan-shaped network of channels and sediments where a river once flowed into a larger body of water, in this case a lake filling a crater in the southern highlands. Other researchers go even further, suggesting that the data provide evidence for large open expenses of water on the early Martian surface. A computer-generated view of the Martian north polar region shows the extent of what may have been an ancient ocean covering much of the northern lowlands. The Hellas Basin, which measures some 3,000 kilometers across and has a floor that lies nearly 9 kilometers below the basin’s rim, is another candidate for an ancient Martian sea.

一些科学家认为早期的火星上广泛存在着河流，湖泊甚至是海洋。一份2003年的对火星全球的调查照片显示了一个科学家们认为是三角洲的构造——一个扇形的沉积物和水流沟渠的网络，河流可能是从这里流入了一个更大的水体；在这种情况下，它可能是南部高地的一个火山口湖泊。其他研究者做了更大胆的猜测，他们认为那些数据表明，早期在火星表面存在大量的水。一张关于火星北部极地地区的电脑图片说明有可能有一个古老的海洋覆盖了北部大部分的低洼处。那座有大约3,000公里宽，9公里深的希腊盆地也可能是火星海洋。

These ideas remain controversial. Proponents point to features such as the terraced “beaches” shown in one image, which could conceivably have been left behind as a lake or ocean evaporated and the shoreline receded. But detractors maintain that the terraces could also have been created by geological activity, perhaps related to the geologic forces that depressed the Northern Hemisphere far below the level of the south, in which case they have nothing whatever to do with Martian water. Furthermore, Mars Global Surveyor data released in 2003 seem to indicate that the Martian surface contains too few carbonate rock layers―layers containing compounds of carbon and oxygen―that should have been formed in abundance in an ancient ocean. Their absence supports the picture of a cold, dry Mars that never experienced the extended mild period required to form lakes and oceans. However, more recent data imply that at least some parts of the planet did in fact experience long periods in the past during which liquid water existed on the surface.

这些观点仍然有争议。支持者们指出照片里显示的台地“海滩”是由湖泊或者海洋蒸发干涸之后或者海岸线退去之后形成的。但是反对者认为这些台地也可能是由于地质活动造成的，也许与使得北半球比南半球地势更低的地质力量有关，在这种情况下，它们就和火星水系没有任何关系。此外，2003发布的火星全球调查数据也表明火星表面含有太少的碳化岩层——含有碳氧化合物的岩层——它们应该是在古代海洋中大量形成的。这些岩层的缺失支持了火星是一个又冷又干燥的星球，并且不可能拥有形成湖泊和海洋的温和气候这一说法。然而，更新的数据表明，至少该星球上的一些部分表面的确在过去很长时间内存在液态水。

Aside from some small-scale gullies (channels) found since 2000, which are inconclusive, astronomers have no direct evidence for liquid water anywhere on the surface of Mars today, and the amount of water vapor in the Martian atmosphere is tiny. Yet even setting aside the unproven hints of ancient oceans, the extent of the past. Where did all the water go? The answer may be that virtually all the water on Mars is now locked in the permafrost layer under the surface, with more contained in the planet’s polar caps.

除了在2000年发现了一些小规模的、不确定的溪谷以外，宇航员到目前为止还没有在星球的任何地方找到液态水存在的直接证据。而且火星大气中水蒸气的含量也微乎其微。然而就算不考虑尚未证明的古代海洋存在的线索，外流沟渠的广泛存在就足以证明在火星上曾有大量的水体，水都去了哪里呢？答案可能是实际上火星上所有的水现在已经封存在其地下的永久冻层中，并且在极地地区最多。