**The Formation of Volcanic Islands**

**火山岛的形成**

Earth’s surface is not made up of a single sheet of rock that forms a crust but rather a number of “tectonic plates” that fit closely, like the pieces of a giant jigsaw puzzle. Some plates carry islands or continents, others form the seafloor. All are slowly moving because the plates float on a denser semiliquid mantle, the layer between the crust and Earth’s core. The plates have edges that are spreading ridges (where two plates are moving apart and new seafloor is being created), subduction zones (where two plates collide and one plunges beneath the other), or transform faults (where two plates neither converge nor diverge but merely move past one another). It is at the boundaries between plates that most of Earth’s volcanism and earthquake activity occur.

地球的外壳并不是由单块岩石形成的，而是许多的“构造板块”严密的组合在一起的，就像是一个巨大的拼图。一些板块承载着岛屿或是大陆，其它的则形成海底。所有板块都在缓慢移动，因为它们都漂浮在密度更大的半液态的介于地壳和地核之间的地幔上。板块的边缘是扩张脊(两个板块分离，新的海底形成的地方)，俯冲带(两板块碰撞，一个倾入到另一个下面)，或者是形成断层(两板块既不聚集也不分散，但只是互相错位)。板块边界是地球上的火山和地震的高发地。

Generally speaking, the interiors of plates are geologically uneventful. However, there are exceptions. A glance at a map of the Pacific Ocean reveals that there are many islands far out at sea that are actually volcanoes—many no longer active, some overgrown with coral—that originated from activity at points in the interior of the Pacific Plate that forms the Pacific seafloor.

一般地，板块内部在地质上是平静的，但也有例外。扫一眼太平洋的地图就知道那里有许多在大海深处的岛屿，它们其实都是火山，其中有许多已经不活动了，一些长满了珊瑚。这些火山都起源于当时太平洋板块内部一些部位在形成太平洋海底时的地质活动。

How can volcanic activity occur so far from a plate boundary? The Hawaiian Islands provide a very instructive answer. Like many other island groups, they form a chain. The Hawaiian Islands Chain extends northwest from the island of Hawaii. In the 1840s American geologist James Daly observed that the different Hawaii Islands seem to share a similar geologic evolution but some are progressively more eroded, and therefore probably older, toward the northwest. Then in 1963, in the early days of the development of the theory of plate tectonics, Canadian geophysicist Tuzo Wilson realized that this age progression could result if the islands were formed on a surface plate moving over a fixed volcanic source in the interior. Wilson suggested that the long chain of volcanoes stretching northwest from Hawaii is simply the surface expression of a long-lived volcanic source located beneath the tectonic plate in the mantle. Today’s most northwest island would have been the first to form. Then, as the plate moved slowly northwest, new volcanic islands would have formed as the plate moved over the volcanic source. The most recent island, Hawaii, would be at the end of the chain and is now over the volcanic source.

为什么火山活动发生在离板块边缘这么远的地方呢?夏威夷群岛提供了一个非常有启发性的答案。就像其它的群岛一样，它们形成了一个岛链。夏威夷群岛链从夏威夷岛向西北扩张。在十八世纪40年代，地质学家James Daly观察到不同的夏威夷岛屿看起来经历了相似的演变过程，但它们所受腐蚀一个比一个严重，所以越往西北方向的岛屿形成时间可能越早。1963年，在大陆板块理论的早期，加拿大的地质学家Tuzo Wilson意识到岛屿年龄的增加可能是因为这些岛屿是板块表面从一个板块内部的固定火山源上方移动的结果。Wilson解释说，夏威夷向西北延伸的火山长链只是一个长期存于板块下、地幔中的火山源在板块表面的表现。现今最靠西北的岛屿可能是最先形成的。它们随着板块向西北移动。新的火山会随着板块的移动在火山源处形成。最年轻的岛屿，夏威夷岛，应该是在岛链的末端，现在应该在火山源上。

Although this idea was not immediately accepted, the dating of lavas in the Hawaii (and other) chains showed that their ages increase away from the presently active volcano, just as Daly had suggested. Wilson’s analysis of these data is now a central part of plate tectonics. Most volcanoes that occur in the interiors of plates are believed to be produced by mantle plumes, columns of molten rock that rise from deep within the mantle. A volcano remains an active “hot spot” as long as it is over the plume. The plumes apparently originate at great depths, perhaps as deep as the boundary between the core and the mantle, and many have been active for a very long time. The oldest volcanoes in the Hawaii hot-spot trail have ages close to 80 million years. Other islands, including Tahiti and Easter Islands in the Pacific, Reunion and Mauritius in the Indian Ocean, and indeed most of the large islands in the world’s oceans, owe their existence to mantle plumes.

虽然这个理论并没有被很快接受，夏威夷和其它群岛岩浆的年龄测试表明了它们的年龄都从活跃的火山开始依次增加，正如Daly所说。Wilson对数据的分析已经成为了板块构造论的核心部分。大多的发生在板块内部的火山爆发都是由地幔柱造成的;地幔柱是从地幔深处涌出的熔岩柱体。只要火山在一个地幔柱上面，它就是一个活动的“热点”。地幔柱很显然是起源于很深的地方，很可能位于地核和地幔的交界处，并且已经活跃了很久。由夏威夷热点形成的最老的火山已经有近8千万年的时间了。其它的岛屿，包括太平洋的塔希提岛和东部群岛，印度洋留尼汪岛和毛里求斯群岛，实际上，多数世界上大洋中大岛都是由地幔柱的扩展形成的。

The oceanic volcanic islands and their hot-spot trails are thus especially useful for geologists because they record the past locations of the plate over a fixed source. They therefore permit the reconstruction of the process of seafloor spreading, and consequently of the geography of continents and of ocean basins in the past. For example, given the current position of the Pacific Plate, Hawaii is above the Pacific Ocean hot spot. So the position of the Pacific Plate 50 million years ago can be determined by moving it such that a 50-million-year-old volcano in the hot-spot trail sits at the location of Hawaii today. However, because the ocean basins really are short-lived features on geologic time scales, reconstructing the world’s geography by backtracking along the hot-spot trail works only for the last 5 percent or so of geologic time.

海洋火山岛和它们的热点轨迹对于地质学家尤其有用，因为它们记录了过去的板块在固定火山源上方的位置。他们因此可以重现海底扩张的过程，以及大陆和大洋盆地过去的地理位置发展过程。比如，根据太平洋板块现在的位置，夏威夷岛在太平洋热点上面。所以太平洋板块5千万年前的位置可以通过移动太平洋板块使得一座有5五千万年历史的岛屿位于夏威夷岛现在所在的热点上以获得。但是，由于海洋盆地在地质年代上是相对短命的，用热点追踪的方法重建世界的地形只适用于最近的百分之五左右的地质时间。