联合国教育、科学及文化组织

宁德联合国教科文组织世界地质公园

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Ningde UNESCO Global Geopark

白云山
Baiyunshan

白云山简介

Introduction to Baiyunshan of Ningde UNESCO Global Geopark

白云山位于宁德联合国教科文组织世界地质公园中部。区内的古火山地质遗迹具有典型性，是研究火山岩岩石学、岩相学、火山构造学的天然场所。九龙洞、龙亭溪峡谷的河道及河道两侧崖壁上，分布着大量壶穴、流水冲蚀沟槽和垂直弧形凹槽，其数量之丰、类型之多、单体之大、发育之系统、保存之完整堪称一绝，极具观赏性和科研价值，是宁德地质公园最靓丽的风景之一。

Baiyunshan is located in the middle of the Ningde UNESCO Global Geopark. The paleovolcanic geoheritage in this area is typical among its kind. Therefore it is the base for studying volcanic petrology, petrography and volcanic structures. Numerous potholes, flow-erosion grooves and troughs, and vertical arc-shaped grooves developed in river courses or cliff walls by the two riverbanks in the Jiulongdong and Longting stream gorge in the area of Baiyunshan. The abundant quantity, various types, big size, systematical development and well preservation make the landform extremely rare. Therefore, the landforms are of significant value for sightseeing and reesarching. They display the river erosional micro-landform and most beautiful scenery in the Geopark.

这条地学科普线路沿着深切峡谷河道曲折逶迤，沿途可欣赏到大量的形态各异的壶穴地貌景观，这里壶穴主要发育在花岗岩基岩河床中，属于河流侵蚀地貌景观。

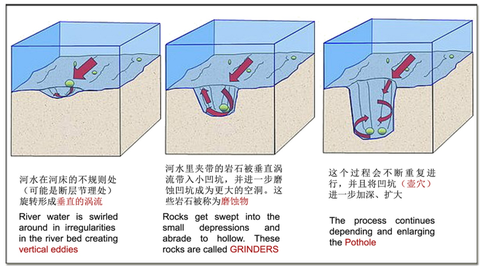
This Geo-trail winds its way along the deep-incised canyon and the upper river course. Visitors can enjoy a variety of potholes which is considered micro geomorphology of river erosional landform. At this place, potholes are mainly developed in granite bedrock riverbed.

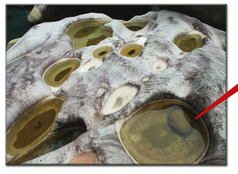
那什么是“壶穴”，它们又是怎么形成的呢？

壶穴是在河流上游经常出现的一种地貌，是指的基岩河床上由于急流漩涡夹带砾石磨蚀河床而形成的凹坑。其深度和直径从几厘米到几米不等。由于水流中携带的砾石对坑穴的侧壁进行不断的刮擦，使得穴壁光滑如镜，其形似壶、似井。壶穴集中分布在瀑布、跌水的陡崖下方及坡度较陡的急滩上。

What are potholes and how are they created?

Potholes are cylindrical holes drilled into the bed of a river that vary in depth & diameter from a few centimeters to several meters. They're found in the upper course of a river where it has enough potential energy to erode vertically and its flow is turbulent. Potholes are formed from abrasion or hydraulic action. As the gravels carried in the water stream continuously scrapes the side wall of the pit, the wall of the pothole is smooth like a mirror, and its shape resembles a pot or sometimes a well. Potholes occur normally at the downstream steep slopes of waterfalls or rapids.





这张照片显示的是在碗状的凹坑底部的鹅卵石。注意底部被磨成圆形的鹅卵——也是因为同样的这种磨蚀作用，形成了壶穴。

Notice how the pebbles are rounded - partly by the same action that scours the pothole.

为何壶穴经常出现在河流上游呢？

白云山的壶穴只分布形成在有流水的河床中，即分布在蟾溪、龙亭溪、黄兰溪、首洋溪峡谷深切曲流中，它们都是处于河流上游的河道。那为啥壶穴经常出现在河流上游呢？

Why do potholes often occur upstream of rivers?

The potholes in Baiyunshan are only distributed in riverbeds with flowing water, that is, they are distributed in the deep-incised streams of Yanxi, Longtingxi, Huanglanxi, and Shouyangxi gorges. They are all in the upper reaches of the river. Why do potholes often occur along the upper reaches of rivers?

河流的上游处在河流发源附近,地势较高且河床成V行,在重力的作用下水流较快。下游处在河流的入海口（尽头）,地势平坦且河床成U形,水流很慢。在河流上游坡度很陡，有足够的势能垂直侵蚀，水流湍急，河流主要以下切侵蚀为主。加上河道里发育了纵向、横向、水平三组节理(即裂缝)。河水夹带砂石很容易在岩石的破裂面上产生磨蚀而形成壶穴。

The upstream is near the origin of the river. The terrain is high and the riverbed is V-shaped. Under the action of gravity, the water flow is faster. The downstream is at the mouth of the river (at the end). The terrain is flat and the river bed is U-shaped. The water flow is very slow. In the upper reaches of the river, the slope is steep and there is enough potential energy to vertical erosion. In addition, there develped vertical, horizontal and horizontal joints in the river course. The river water entrained with sand and gravels stimulate erosion process on the rock's fracture surface and form potholes.

另一个因素是宁德世界地质公园地处东南沿海，受夏季风的影响，年降雨量丰富，年降雨量可以达到 1525 mm，带来了丰沛的流水，流水产生的漩涡携带砂石对河床基岩的磨蚀能力就越强大，其侵蚀力就越强，壶穴也就易在这里产生。

Another factor is due to the location of the Geopark, which is on the southeastern coast. Affected by the summer monsoon, the annual rainfall can reach 1525 mm, which brings abundant water. The eddies generated by flowing water carry sand and gravel on the riverbed. The more powerful the erosion is, the more potholes form here.

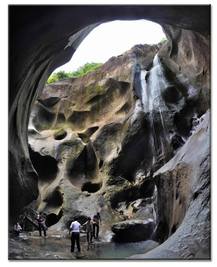
葫芦潭 Hulu（Calabash-like）Pool

河床基岩上顺流水方向分布的数个相邻壶穴，经流水侵蚀壶穴间的前壁和后壁高度逐渐降低，相连成串珠壶穴。串珠壶穴被流水侵蚀切穿后，相邻壶穴的两侧壁分别相连，形成侧壁呈“S”形波状弯曲的流水冲蚀弧壁沟槽。葫芦潭为五个大型瓮状壶穴串通而成的弧壁槽状壶穴。

There were several nearby potholes distributed on the bedrocks of the riverbed along current direction. The river erosion further caused the lowering of the front and back walls of the potholes and made them connected like linked beads. The final penetration of the front and back walls has converted the beaded potholes to a sidewall-connected trough with curved, S-shaped sidewall.

飞天井 Feitian Well

“飞天井”为流水冲蚀和旋涡流的侧蚀形成的大型“穿壁瓮状壶穴”，深 38 米，直径约 23 米。在弧形内壁高度为 15～10 米、8～6 米和 5 米处分布有状似壁龛的凹坑，反映了壶穴底部处于那一高度时旋涡流的侧蚀作用较强。壶底有 8 个单体或聚合壶穴，大者直径 3 米，小者 0.5 米～0.8 米。



The Feitian Well is a huge wall-penetrated jar-like pothole with a diameter of about 23 m and a depth of 38 m. The well is the product of both flow erosion and eddy side erosion. There are habitaclelike pits developed on the inner wall at three levels, 5 m, 6 8m, and 10 15m respectively from the well bottom, suggesting the stronger side erosion of the eddy flow once at the levels. The bottom of the well has eight single or assembled potholes. The big one has 3 m in diameter, but small ones only 0.5 -0.8 m

水蚀沟槽 Water erosion-induced grooves

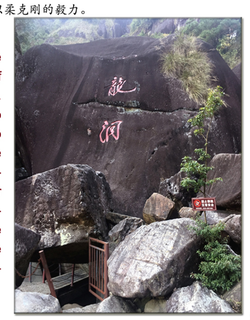
花岗岩主要含有钾长石和斜长石等矿物，这些矿物都易发生碳酸盐化作用，变成粘土矿物，因而花岗岩容易遭受风化而破坏。当花岗岩的垂直节理较发育时，沿节理缝由于上述作用造成的长石、石英等造岩矿物的水解流失，本地降雨丰沛，在长期雨水冲刷下，在风化面上形成了一条条褐色的凹槽--流水冲刷槽。

It is a unique phenomenon of water erosion. Granite mainly contains minerals such as potassium feldspar and plagioclase, which are easy to carbonate and become clay minerals, so the granite is easily damaged by weathering. When the vertical joints of granite are more developed, the hydrolytic loss of rock minerals, such as feldspar and quartz are eroded. This area is rich in rainfall. Under the long term rainwater scour, a strip of water scour grooves are formed on the weathered surface

九龙洞 Jiulong Cave

九龙洞是溪流两侧崖壁因重力崩塌滚落至河床的巨大砾石堆积而成的迷宫状“巨砾堆积洞”。洞内河床基岩及滚石上的壶穴形态各异，在惊叹大自然的鬼斧神工之余，您能从中感悟到流水以柔克刚的毅力。

The Jiulong Cave is a maze-like cave formed by the accumulation of huge rock blocks on the riverbed. The blocks were fallen from two side cliffs of the river due to gravitational collapse. Inside the cave, you can see differently-shaped potholes on the riverbed or rolling stones and may be astonished by nature's great power. Are you also aware of the truth that the soft methods （water） can overcome the strong（rock）.

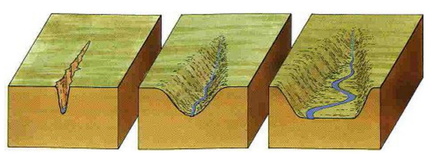


V形谷 V-shaped valley

由于这里是河流上游，直接连着河源，河道落差大、水流急、下切力强，处于深山峡谷中，河谷狭呈“V”字。

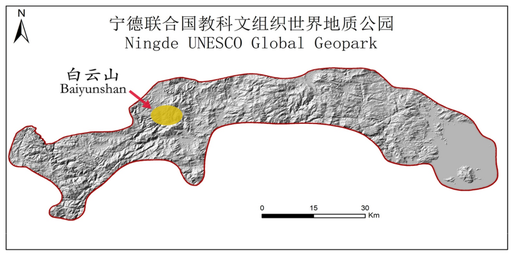
Because this is the upper reach of the river, directly connected to the river, the river course has large drop with rapid flow, and strong undercutting power, forming deep-incised valley and the valley is in a “V”shape.

V形谷是怎么形成的?
How does a V – shaped valley form?



V形谷由于以下共同的原因和形成：a. 河流本身的下切侵蚀;b. 物理风化（如霜冻作用），提供向下移动的碎屑物质; c. 块体运动（比如：土壤蠕动和滑坡）将碎片向坡下移动。

A V-shaped valley formed due to a combination of the following processes: a. Vertical erosion by the river itself; b. Physical weathering (eg: frost action) which provides debris to move down slope; c. Mass movement (soil creep & landslides) to move debris down slope.



白云山地质科普游步道导览图

Geo-trail of Baiyunshan in Ningde UNESCO Global Geopark