Sanqingshan —— the Hidden Treasure of China

Piotr MIGON

Department of Geography and Regional Development, University of Wroclaw, Poland

Abstract: The Sanqingshan massif in south-east China is an area of unique high-mountain landscape, distinguished by an exceptional assemblage of geomorphological phenomena. Bedrock consists of granite intrusion of Cretaceous age. The predomhinance of vertical joints plays decisive role in the origin and evolution of high conical peaks and rock pinnacles, columns, and precipitous slopes as high as 300 m. Intervening ravines and clefts have developed along heavily fractured zones. High altitude gradients allowed for the development of a zonal vegetation pattern. Sanqingshan has a status of a national park and a geopark. Currently an attempt is made to nominate Sanqingshan as a World Heritage Site of UNESCO.

Key words: granite; geomorphology; geopark; China

0 Introduction

China as a country is immensely rich in sites and areas of outstanding geological, geomorphological and landscape value. In recent years, concurrently with the general opening of China to international tourism, lifting of administrative restrictions imposed on travelling, and the development of geoconservation, an increasing number of such places receives recognition as geotouristic destinations. There are places well known and visited over many years, such as the famous karst region of Guilin or the sacred mountain of Huangshan in the Anhui province, but in general the geotouristic potential of China is still insufficiently realized abroad. The reasons for this situation are varied, but they are likely to reside in the huge size of the country and its bio- and geodiversity, as well as in its historical legacy and the shortage of information available in languages other than Chinese. Hence, there is no wonder that certain areas of truly exceptional natural beauty are virtually unknown outside China. One of these is the granite massif of Sanqingshan in the Jiangxi province, which has a landscape unparalleled at the global scale (Plate Ⅰ-1). The main aim of this paper is to provide a short introduction to the environment of Sanqingshan.

1 Location and geological context

Sanqingshan is located in southeastern China, in the Jiangxi province, c. 250 km to the east from its capital Nanchang and c. 500 km to the south-west from Shanghai (Fig. 1). It belongs to the northern part of the South Chinese Mountain Ranges, which themselves are a rejuvenated orogenic terrain of Mesozoic age, rising to 1500～2158 m a. s. l. The highest peak in Sanqingshan attains 1816 m a. s. l., while the entire massif covers some 25 km^2 and rises by 300～500 m above the surrounding mountain terrain. The entire mountainous area in the north-eastern part of the Jiangxi province, of which Sanqingshan is a component, is known as the Huaiyu Mountains.

From the climatological point of view, the area belongs to the zone of transitional, monsoonal tropical climate (Martyn[1]). The mean annual temperature is c. 11℃, with the mean temperature of July exceeding 21℃, and that of January being

Manuscript received: 2007-03-10; accepted: 2007-06-15; edited by: JIANG Shaoqing, ZHANG Yuxu.

Author introduction: Piotr MIGON, Professor of the Department of Geography and Regional Development, University of Wroclaw, Poland. Address: Uniwersytecki 1, 50-137 Wroclaw, Poland; Email: migon@geogr. uni. wroc. pl.

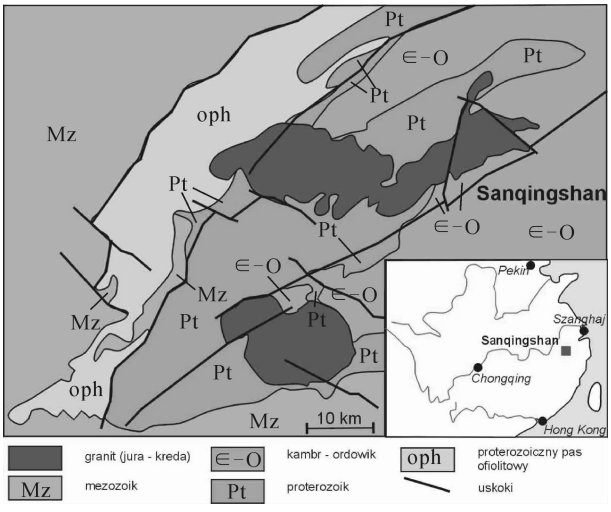


Fig. 1 Location of Sanqingshan on the background of geological structure of the vicinity (after Mount Sanqingshan National Park)

1.6℃. The near-coastal setting of Sanqingshan accounts for frequent summer arrivals of moist maritime air masses, bringing abundant rainfall. The mean annual rainfall is 1858 mm, including some snow fall in the winter months. The majority of precipitation is recorded in late spring and early summer. Occasionally typhoons pass over Saningshan.

Geologically, Sanqingshan occupies a setting near an important tectonic boundary between two paleoplates: the Yangtze Plate to the north and the Cathaysia Plate to the south. The boundary itself is an ophiolitic suture zone, with a considerable role played by melanges built of metamorphosed rocks of the ophiolitic complex, phyllites, glaucophane schists, and quartz diorites. The age of the ophiolitic complex is estimated at about 900 million years (Xu et al.[2]).

The granite intrusion which builds the Sanqingshan massif is much younger (Fig. 1) and is one of many intrusions of Mesozoic age, common throughout southeastern China and related to the Yanshanian orogenic movements. These occurred along the boundary between the Eurasia and Paleopacific Plates, where subduction generated intrusions of magma of granitic composition. However, the source of magma was not identical throughout the entire process, so that the oldest magmas are of I type, followed by the S type magmas derived from molten sedimentary rocks, and ending with the A type in the post-orogenic stage. The intrusion of the Sanqingshan granite occurred, according to K-Ar dating, c. 115 Ma ago and contained the A type magma. Still younger, dated for 87～97 Ma, is the stock building the highest peak of the massif, Yujing (Yin et al. 2006) (Fig. 2). The depth of emplacement of magma in the main intrusive phase is estimated to be 4～4.5 km.

In the next stage of geological evolution, during the late Cretaceous, the area acquired the characteristics of a basin-and-range terrain and was subject to strong extension. Considerable altitude gradients resulted from differential vertical movements of high amplitude, which set the stage for vigorous denudation. As early as in the latest Mesozoic the Sanqingshan massif was striped, so that 4 to 5 km of country rock must have been eroded away. Products of denudation filled intermontane basins, giving rise to the 'red bed' formation, typical for southern China and built mainly of sandstone. Dome-like hills built of sandstone belonging to the red bed formation occur along the road connecting the city of Shangrao and the Sanqingshan massif.

By the end of the Cenozoic, differential crustal movements resumed and the massif of Sanqingshan has been subject to strong uplift. The rate of uplift appears to significantly exceed the mean uplift rate of the Huaiyu Mountains, hence the Chinese geologists describe this situation as 'uplift-on-uplift'. The boundaries of the elevated block are made of three fault zones, trending SSW—NNE, NW—SE, and SW—NE, respectively. Together, they enclose an area of some 30 km^2, built not only of the granite of Sanqingshan, but also, in marginal parts, of Proterozoic limestone, Ordovician slate and limestone (Fig. 2).

The granite of Sanqingshan is predominantly medium-grained, with a high content of silica (77%), an elevated content of potassium (4.7%

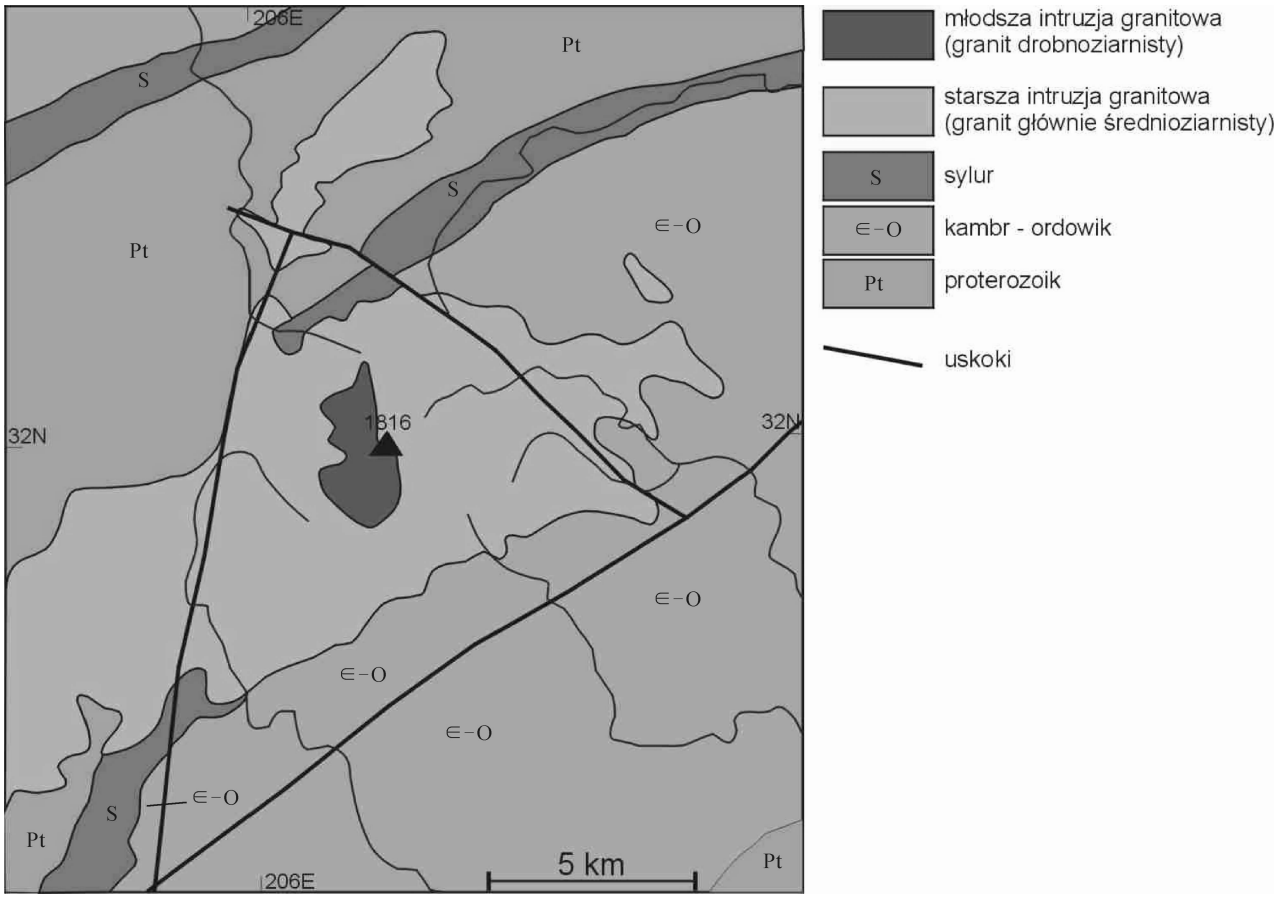


Fig. 2 Geology of Sanqingshan (after Mount Sanqingshan National Park)

K_2O) and a low content of calcium (0.5% CaO). The central stock of Yujing is more fine-grained than the rest of the major intrusion. The fracture pattern is dominated by vertical fractures trending in different directions, although fracture density is much varied. Next to very massive compartments, with joints spaced as much as 20 m apart, there occur densely jointed and shattered zones from a few to more than 10 m wide (Plate Ⅰ-2). Flat-lying joints play a very subordinate part.

2 Landscape and relief evolution

The uniqueness of Sanqingshan, and also its geotouristic potential, derives mainly from its geomorphology, unsurpassed among granite mountain massifs on the world scale. The key landforms are closely spaced high peaks of conical and pinnacle shape (Plate Ⅰ-1), multiple sharp cones rising from a common base, rock walls, spurs and crests, massive rectangular towers (Plate Ⅰ-3), continuous rock precipices forming valley sides, and solitary columns separated by deep clefts and ravines. The height of individual peaks and precipices may be as much as 300 m, whereas isolated granite columns are tens of meters high. The highest of them, the Big Boa, is 128 m high (Plate Ⅰ-4).

The shape and distribution of the main relief forms reflect the characteristics of the fracture patterns, which are of decisive significance in any attempts to explain the origin of this unique landscape. Vertical zones of bedrock shattering guide outlines of individual peaks and rock walls, and are exploited to form clefts and ravines of considerable longitudinal gradient. Typical assemblages of cones and pinnacles rising from a common base reflect a criss-cross pattern of vertical joints. Master joints control the outline of

a rock crest, whereas the division of the crest into individual pinnacles occurs along perpendicular, second-order joints (Plate Ⅰ-5). Less frequently the course of main fractures is irregular. If this is the case, the shapes of residual landforms are less regular too (Plate Ⅱ-1).

Vertical joints, as well as infrequent flat-lying joints, are probably older than the principal features of the geomorphology of Sanqingshan. However, there also occur secondary joints, most likely related to unloading of the rock mass. They are roughly parallel to the slope surface and dip at high angles (>50°), being diagonal to the primary vertical joints(Plate Ⅱ-2). These secondary joints are very important for hillslope development and control the pattern of mass movement, providing ready surfaces of shear, slip, and detachment. They are particularly frequent in the less elevated parts of the massif, along valley sides, accounting for extensive, smooth and steeply inclined rock slope segments.

The most varied shapes of residual towers and pinnacles are also related to weathering processes, responsible for progressive rounding of initially angular forms (Plate Ⅱ-1). The principal mechanism of breakdown is granular disintegration, caused by thermal changes, by frost cracking in winter months, and under the influence of living organisms. Numerous columns have been named, with the names themselves relating to both curious rock shapes and Chinese mythology and legends.

For the geomorphological picture of Sanqingshan, concave landforms are equally important. In the most elevated part of the massif, above 1500 m a. s. l., valleys in the strict sense can hardly be distinguished. Instead, we deal with narrow and deep ravines of considerable gradient, which exploit zones of structural weakness and dense fracturing. They are party infilled by huge residual granite boulders, some exceeding 10 m in diameter, which testify to the abundance of rock fall from the steep slopes. More evident valleys occur at lower altitudes and these are invariably sharply V-shaped, indicative for high rates of incision hardly matched by the rates of slope surface lowering (Plate Ⅱ-3). Their floors are also littered with boulders, but in numerous places bedrock is exposed, revealing a high density of jointing. Waterfalls occur in places, where streams cross bands of massive granite. The highest waterfall in the massif is 60 m high. The spatial patterns of V-shaped valleys is radial in respect to the centre of the massif.

Unfortunately, little is known about the geomorphic history of Sanqingshan and its controlling factors in the longterm. Therefore, the view offered below is based on the author's own observations in the massif, compared against published data from other granite massifs. It appears that the unique geomorphology of Sanqingshan has resulted from a combination of three factors: ① rapid uplift of the massif, ② bedrock characteristics, and the dominance of vertical joints of variable spacing in particular, and ③ environmental conditions, mainly abundant rainfall leading to high runoff. The tectonic factor is responsible for maintaining considerable elevation gradients, which is crucial for stream power and erosional ability of streams draining the massif. At the same time, bedrock structure dictates that erosion is focused on narrow, densely jointed zones which are therefore rapidly deepened. Considerable massiveness of the granite next to these zones, along with its high mechanical strength, allow the valley sides to assume the form of nearly vertical rock walls and to maintain it despite the progress of incision. Large-scale rock slope failures do take place, but toppling and slides occur along vertical or steeply dipping discontinuity planes, not leading to change in slope form in effect (Fig. 3). In the Pleistocene, either the elevation of Sanqingshan was below the snowline, or the steepness of the slopes precluded accumulation of larger volumes of snow. There is no evidence that glacial processes have been involved in shaping the morphology of the massif.

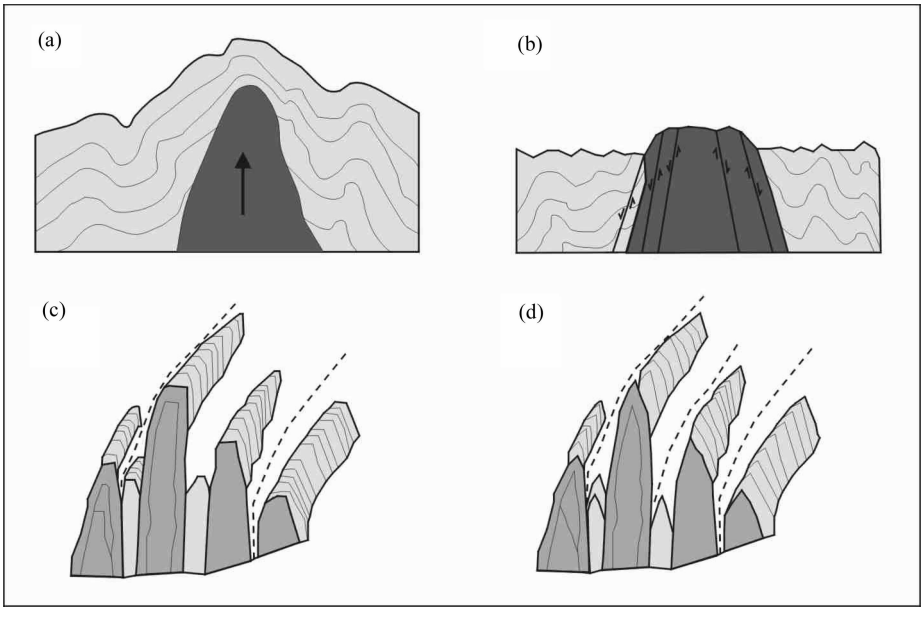


Fig. 3 Diagram showing the evolution of rock formations of Sanqingshan (after Yin et al., 2006)

(a) — granite intrusion into older Proterozoic—Paleozoic rock formations, (b)— Neogene uplift along steeply dipping faults, (c)— separation of individual compartments, delineated by fracture zones, (d)—remodelling of angular blocks into cones and pillars

3 Ecosystems

The uniqueness and natural value of Sanqingshan result not only from its geological history and geomorphology. Considerable elevation gradients and consequent climatic differentiation account for the existence of clearly marked vegetation belts. In the low-lying terrain, up to 500 m a. s. l., there occurs subtropical, evergreen broad-leaved forest, with various species of chestnut trees, laurel, and oak. Between 500 and 1000 m a. s. l. mixed forest communities gradually appear, with deciduous trees increasing in number and dominating above 1000 m a. s. l. (plate Ⅱ-4). The highest peaks, above 1500 m a. s. l., host the coniferous communities of *Pinus taiwanensis* and compact groups of *Pseudotsuga gaussenii*.

From a general landscape point of view, solitary trees and small clusters of Pinus, Taxus, and Torrea, living on pinnacle tops and within precipitous slopes, merit special attention (Plate Ⅱ-5). Together, they add a unique aesthetic dimension to the natural landscape, considered by many as very specifically Chinese. In a few places there are large groups of azalea, showing particularly magnificent blooms in spring.

Among individual species, the abundance of *Pseudotsuga gaussenii* and Tsuga, close relatives of species thriving in the mountains of western North America, are highlighted. Such a geographical distribution, given the absence of a land connection between the two areas, indicates the presence of a common ancestor in times prior to the separation of the Eurasian and North American plates. In the flora of Sanqingshan 30 endemic species have been identified and 19 endangered species, all featuring in the Chinese "Red Book". The animal world is very varied too, with seven species having the priority status in the national system of nature conservation, including *Muntiacus crinifrons*, leopard, two species of pheasants, and a rare butterfly *Teinopalpus aureus*.

4 Conservation and access

For a considerable time, Sanqingshan had

remained relatively less known and less visited, which may have been partly related to the proximity of another granite massif, Huangshan. The latter, located c. 150 km to the north, has long been recognized as a site of outstanding landscape and cultural value, and is a most popular tourist spot. In 1990 Huangshan was inscribed on the UNESCO World Heritage List as a mixed site. Efficient advertising of Sanqingshan has also been hampered by its rather peripheral location in the Jiangxi province. Even today, the massif is virtually unknown outside China, there is marginal tourism from abroad, whereas best selling guidebooks to China, such as 'Lonely Planet' do not even mention Sanqingshan.

In 1988 Sanqingshan received the status of a national park, and in 2005 was proclaimed a national geopark, in recognition of its exceptional geological and geomorphological values. Recently a campaign has been launched to inscribe Sanqingshan on the World Heritage List of UNESCO as a natural site. However, it is difficult to say at the moment if and when these attempts will be successful.

The intensity of tourism in Sanqingshan can still be assessed as moderate, although the growth is very rapid. In 1998 the park was visited by 37,000 people, but in 2004 there were as many as 298,000 visitors, which is an almost tenfold increase. Action is undertaken by the Management Committee of the National Park to enhance the touristic infrastructure, so that the most attractive parts of the area can be accessed by an ever-growing number of visitors, without a detrimental effect on the natural assets. Currently, there is about 50 km of well managed, comfortable walking trails within the national park area, including——as a true highlight——the "Sky Path" opened in 2005. It goes round the most elevated parts of the park, traversing the precipitous slopes (Plate Ⅱ-6). Along this, and other paths interpretative panels have been erected, although an emphasis is on vegetation, with scant attention to geology and relief evolution.

Regardless of the final decision concerning the World Heritage nomination of Sanqingshan, it is beyond doubt that it represents an area of truly outstanding natural values and unique geomorphology. The latter is the outcome of a range of geological and climatic—environmental controls, influencing each other. Sanqingshan deserves visiting and while discovering its unique beauty, a reflection might come to mind as to how many more 'hidden treasures' of nature exist on the territory of China.

Acknowledgements: My visit to Sanqingshan followed an invitation from the directors of the National Park, Mr. Liu Shuzong and Mr. Yang Shaowu, which are gratefully acknowledged. Excellent assistance during the stay was provided by Ms. Qiu Hong, Mr. Yu Honghu, Ms. Guo Shuilian, and Ms. He Jian. I am also grateful to Professors Chen Anze and Li Jianghai for discussions about the granite geomorphology of China.

This paper has originally appeared in Polish as: Migon P., 2006, Sanqingshan —— ukryty skarb Chin [Engl. summ. Sanqingshan —— a hidden treasure of China], Geoturystyka, vol. 2 (5), p. 33 ~ 40, Krakow, Poland. English translation re-published with the permission of the editors of "Geoturystyka".

Notes

❶ Ministry of Construction of People's Republic of China. Mount Sanqingshan National Park (draft of nomination document). Beijing, 155 pp. (no date provided).

❷ Yin G, Ma Z, Liu X, Yang Y, Yang M, Long M. 2006. Study on "Mount Sanqingshan-Type" granite geology and landscape. in: Proceedings of the First International Symposium on Geology and Geomorphology of Granite, Sanqing Mountain, China. 62~83 (in Chinese with English abstract).

References

Martyn D. 1985. Klimaty kuli ziemskiej. PWN Warszawa, 667 s.

Xu B, Guo L, Shi Y. 1992. The Proterozoic terrain and orogenic belt of multi-stage collision in Anhui — Zhejiang — Jiangxi ares. Beijing: Geological Publishing House.

Explanation of Photos

Plate Ⅰ

1. General view of the Sanqingshan massif. The highest peak, Yujing (1817 m) is hidden in the clouds. 2. Narrow zones of heavy rock fracturing, typical for the Sanqingshan massif.
3. One of many assemblages of joint-controlled rock pillars. An absence of horizontal fractures is notable.
4. "Big Boa" —— an isolated granite column.
5. A group of residual pillars, showing clear adjustment of form to the fracture pattern.

Plate Ⅱ

1. "Oriental Goddess" (86 m high) —— one of the landmarks of the Sanqingshan massif.
2. Steeply dipping unloading joints on a rock pillar.
3. Deeply incised, V-shaped fluvial valleys within the southern slope of Sanqingshan..
4. Fragment of the mixed forest belt at around 1300 m a. s. l.
5. Scattered pines (*Pinus taiwanensis*) in the most elevated part of Sanqingshan.
6. Sky Path is the main touristic trail in the Sanqingshan massif.

三清山——中国的隐秘财宝

Piotr MIGON

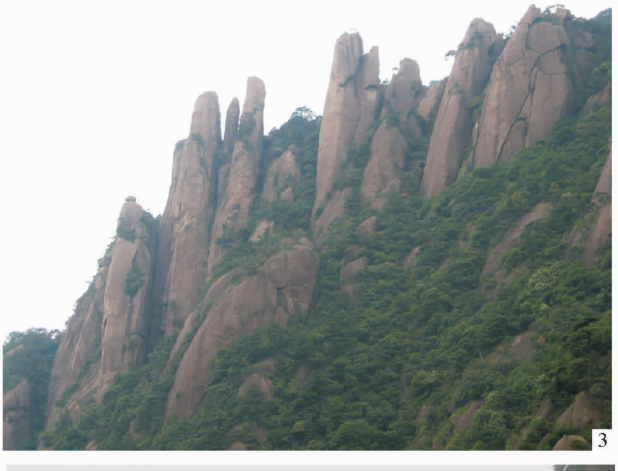
Department of Geography and Regional Development, University of Wroclaw,
pl. Uniwersytecki 1, 50～137 Wroclaw, Poland;
e-mail: migon@geogr. uni. wroc. pl

内容提要:三清山地块地处中国东南部,具有独特的高山地貌,并以其特殊的群峰地貌而著称。基岩由白垩纪花岗岩侵入体组成。大规模发育的垂直节理导致形成高大的圆锥状的山峰、石塔、石柱和陡坡、峭壁,高度可达300m。山峰之间的峡谷和裂缝发育于强断裂带。巨大的高差形成了垂直地域植被分带。三清山具备国家公园和地质公园的条件。现在,正在努力把三清山向联合国教科文组织提名为世界遗产。

关键词:花岗岩;地貌学;地质公园;中国

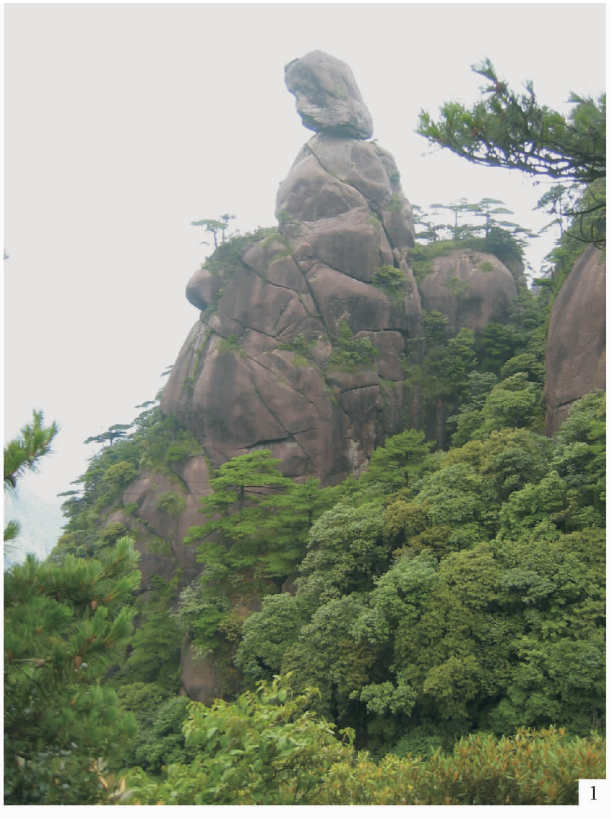

1

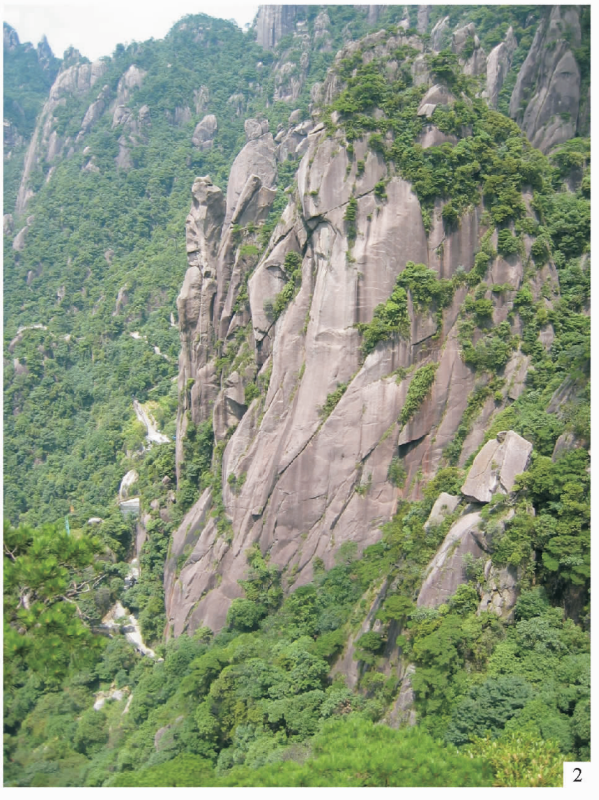

2


3

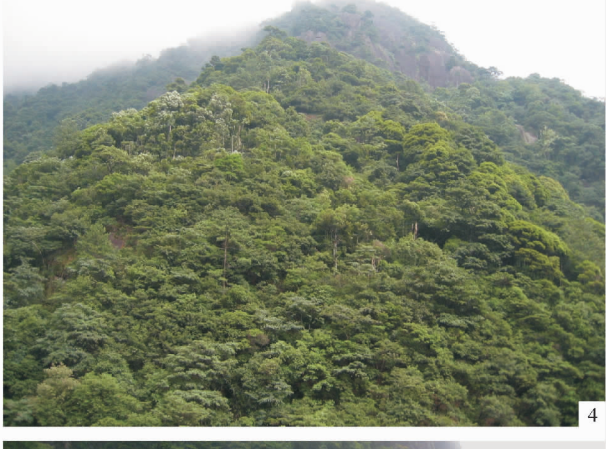

4


5


1


2


3


4


5


6