

TAIWAN GEOTOURISM – A VOLCANIC EXPERIENCE

Angus M Robinson¹ and Jiun-Chuan Lin²

¹ Chairman, Geotourism Sub Committee, Geological Society of Australia
angus@leisuresolutions.com.au

² Professor, Department of Geography, National Taiwan University
jclin@ntu.edu.tw

INTRODUCTION

The beautiful island of Formosa, now known as Taiwan, has been described as ‘standing at the crossroads of nature and development’. With a population of just over 23 million, not dissimilar in size to that of Australia, Taiwan comprises an area about one half of the area of the Australian island state of Tasmania. Most visitors to Taiwan are familiar with the industrial landscape that extends down the western half of the island, but have not been exposed to the beauty of its central mountain ranges and coastal environs of Eastern Taiwan.

In a geographical sense, Taiwan’s outstanding natural heritage epitomises the definition of geotourism – its environment, culture, aesthetics, heritage, and the well-being of its residents (National Geographic, 2005). But from a geological tourism perspective which focuses on geology and landscapes, Taiwan offers a diversity of unique experiences, which includes both dormant volcanism and outstanding volcanic landforms.

As Lonely Planet has described Taiwan, ‘Mountain peaks puncture a sea of clouds, slick black volcanic rock wraps the coastlines, and waterfalls shroud themselves in mist. Taiwan is a computer-generated Chinese water colour.’

Geographical location of Taiwan
Type of volcano[es]: strato-volcanoes, fumaroles, steam vents, undersea fumaroles, crater lakes, boiling mud pools, flood lava flows with distinctive columnar jointing
Last known activity: Volcanic activity ranges from early Miocene, through Pleistocene to present
Major attractions: Yangmingshan National Park, Turtle (Guishan) Island, and Penghu Marine Geopark
Status of protection if any: national parks, nature reserves, wildlife refuges, wildlife habitats, forest reserves, ecological parks, national geoparks
Visitor numbers: 4.7 million inbound tourists (2012) engaged in sightseeing principally.



Figure 13.1 *Principal Volcanic Areas of Taiwan*

TAIWAN – THE PLACE

Lying on the Tropic of Cancer, Taiwan is located 150 km off the southeast coast of mainland China, between cool-temperate Japan to the north, sub-tropical South China to the west, and the tropical Philippines and Indo-Malayan islands to the south. The location, combined with a range of high mountains, with more than 200 peaks over 3,000 m in height, supports a diverse flora of over 4,000 vascular plant species and a spectrum of six forest types. This range of environments in turn supports a rich fauna, flora, and biological diversity. In addition to this big island, there are over 120 outlying small islands falling into a number of groups, each group contains one or several inhabited main islands (or temporary fishing stations or army outposts) and other smaller isles. It is reported that only some 25 of these islands are inhabited. The diversity of these small-island groups emerges from their differences with respect to geological origin, size, remoteness, geographic types, and human culture (Huei-Min Tsai, Taiwan Islands Net).

Of these island groups, three have volcanic origins (refer also **Figure 13.1**).

Mid-oceanic archipelagos type: Penghu Archipelago comprising 64 small islands and islets; composed of basalt with a coral reef coastline.

Remote oceanic islands type: Green Island (Lutao), volcanic with coral reef and Orchid Island (Lanyu), volcanic with a sub-tropical rain forest.

Near-shore or connected islands type: Turtle Island (Guishan), active volcanic with accompanying undersea thermal springs, and the five islands off north-eastern Taiwan, Pengchiahsu (Pengchiayu), Mienhuahsu (Mienhauyu), Huapinghsu (Huapingyu), Chilungtao (Chilungyu) and Kueishantao, all volcanic islands formed of either andesite or dacite.

GEOLOGY OF TAIWAN

(Source: Central Geological Survey of the Ministry of Economic Affairs)

Taiwan is a modern mobile belt in the classical sense, and an orogeny formed by the collision of an island arc with the Asian continental margin. The main island of Taiwan comprises in part a metamorphic basement covered by Cenozoic deposits to a thickness of more than 10 km. The north-south axis of deposition has shifted progressively westward with successive orogenic episodes. A considerable part of the Tertiary sediments of Taiwan has been subjected to different grades of induration or metamorphism. Large igneous intrusions are rare, but there are several important volcanic fields in northern Taiwan, eastern Taiwan, and the Taiwan Strait. Taiwan is located on a convergent plate boundary between the Asiatic continental plate and the Philippine Sea oceanic plate.

The major rock formations of Taiwan form long narrow belts roughly parallel to the long axis of the island. These rock belts extend progressively westward from the central backbone range to the west coast. The prevailing structural pattern is that of an elongate arc convexing to the west. The northern, shorter bend of the arc strikes east-north-east whereas the southern, major arm of the arc extends mainly north-south. All the major structures of Taiwan, including the important faults and fold axes, follow fairly closely this arcuate structure throughout the island.

Oligocene to Miocene Age Volcanism

In the western foothills, small-scale volcanism was active in the sedimentary basin from late Oligocene to Miocene times and ended in the Pliocene. In northern and north-central Taiwan, small lenses or irregular bodies of basaltic tuff, tuffaceous breccia and

minor basaltic flows are present in all Miocene formations, but their distribution is limited to scattered local areas only.

The Coastal Range in eastern Taiwan is a volcanic arc containing a large amount of volcanic rocks and their pyroclastic derivatives. The most important igneous mass is the Chimei Igneous Complex, which outcrops also in a small exposure in Changyuan southeast of Chimei. The pyroclastic rocks of the Tuluanshan Formation are also associated with this phase of volcanism. The main constituents of the Chimei Igneous Complex are andesites of different mineralogical compositions and textures. These rocks are mainly of Miocene age. The two offshore islands in south eastern Taiwan, Green Island (Lutao) and Orchid Island (Lanyu), are composed of the same andesites and pyroclastic rocks. Their ages range from Miocene to Pliocene. All the igneous rocks in the Coastal Range are related to the Luzon Volcanic Arc, which is a chain of volcanoes in a north south line across the Luzon Strait from Taiwan to Luzon.

On the Penghu Island Group in the Taiwan Strait, fissure eruptions produced a widespread flood basalt that covers 64 islands and islets. This basaltic volcanic stage may occur at the end of the main orogeny in Taiwan and is of early to late Miocene age (17.4 to 8.2 million years ago). These basalts cover the entire island group except the westernmost island, Huahsu. They form flat-topped tablelands reaching a maximum elevation of some 50 m above sea level. Horizons of sand, clay, and carbonised wood fragments are inter-bedded with the basalt flows. The Penghu basalt erupted quietly, as pyroclastic deposits are comparatively limited. The eruption produced nine successive flows. The basalt is either dense and compact or amygdaloidal. Amygdules are generally filled with aragonite. These amygdaloidal basalts provide an ornamental stone for which Penghu is noted.

Pleistocene Age to Recent Volcanism

Large-scale andesitic eruptions took place in Pleistocene time in northern Taiwan and in some north-eastern offshore islands, depositing both lava and pyroclastic rocks. Two important Pleistocene andesitic volcano groups were formed, the Tatun Volcano Group and the Chilung Volcano Group, located on the west and the east side of the Chilung harbor respectively. No volcano is known to be active in Taiwan in the historical record, but geothermal evidence suggests that these volcanoes may not be entirely extinct.

The Tatun volcanoes are more mafic and contain some basaltic flows, whereas the Chilung volcanoes are more acid, composed mainly of dacite or quartz andesite. The five islands off north-eastern Taiwan (Pengchiayu, Mienhauyu, Huapingyu, Chilungyu, and Kueishantao) are all volcanic islands formed of either andesite or dacite. They are ascribed to the same volcanic belt and stage as those in northernmost Taiwan. These

represent the western end of the Ryukyu volcanic arc. Fumarolic activity is present on at least two of these islands.

The Tatun (Datun) Volcano Group comprises a series of 20 volcanoes and volcanic cones in the northernmost part of Taiwan, the nearest being 15 km north of Taipei. Qixing Mountain (Chihshingshan) at an elevation of 1,120 m is the highest and youngest volcano in the group. Hot springs, fumaroles, and shallow volcanic craters are found at many places in this volcano group, mostly on the southeast side of the Chinshan longitudinal fault. Craters are preserved at the summit of some of the cones. A few have been eroded to craterless volcanoes or were erupted as high-viscosity volcanic domes. This group of volcanoes are mainly strato-volcanoes, built by successive eruptions of andesitic flows, volcanic ash, and coarse pyroclastic ejecta. Another peak, the Kuanyinshan volcano, rising to 612 m, is separated from the main volcanic chain by the Tanshui River. Guanyin Mountain (616 m high) is located at the most north-westerly edge of the Tatun Volcano Group.

Numerous quartz andesite or dacite flows are found on the north-eastern coast of Taiwan, east of Chilung harbour. These flows and associated pyroclastic rocks constitute the Chilung Volcano Group. Related gold and copper mineralisation is found in the Miocene host rocks or at the intrusive margins, forming the three principal deposits at Chinkuashih, Chiufen, and Wutankeng.

Pleistocene volcanism is represented at a location just south of the town of Tachi in Taoyuan-hsien in northern Taiwan by a conical volcanic hill rising to 347 m. It is made up of vesicular alkaline basalt (the Tsaolingshan Basalt) with a small amount of pyroclastic deposits exposed on the southern slope.

Turtle (Guishan) Island, located some 9 km east of Hengfang Harbour on Taiwan's north-eastern coast, represents the top of an andesite stratovolcano which rises from the seafloor, displaying active undersea fumaroles. The last recorded eruptions were during the period 1775-1795 AD.

The Wandan mud volcano, one of Taiwan's 17 active mud volcanoes was dormant for nine years between 1979 and 1988 but now usually erupts once or twice a year. There are two active mud volcanoes in South Taiwan, and several inactive ones. The Wushan mud volcanoes are located in the Yanchao District of Kaohsiung City, and are protected since 1992 as part of Taiwan's smallest nature reserve.

Taiwan's Geopark Network

Professor Jiun-Chuan Lin of the Department of Geography, National Taiwan University has advised that the Taiwan Geopark Network was launched in 2011. The purpose of Taiwan Geopark Network is to establish a national network for promoting the concept of a geopark, exchange the experience of management of the sites, to educate visitors to protect the landscape for the purpose of sustainable development during using or visiting the geological/ geomorphological/ ecological and cultural heritage, and to promote the local economic activities through geopark activities.

Six identified Taiwan geoparks (i.e. Northern Coast, Penghu Marine, Liji, Yangchao, and Caoling) have different landscape characteristics, of which two – the Northern Coast and Penghu Marine comprise either part or full volcanic landforms (Figure 13.2).



13.2 Taiwan Geoparks Network

In 2009, Taiwan hosted the East Asian Geoparks Conference (Lin, 2009).

**TAIWAN'S NATIONAL TREASURES – PROTECTED AREAS IN TAIWAN –
AN OVERVIEW**

Taiwan's natural heritage is protected in eight National Parks i.e. Kenting, Yushan, Yangmingshan (features the Tatun volcanoes), Taroko, Shei-Pa, Dongsha, Kinmen and Taijiang as well as 13 designated scenic areas, with large areas of indigenous sub-tropical forest, particularly on the east Coast, and spectacular ocean scenery.



Figure 13.3 *Taiwan's spectacular Taroko Gorge, Taroko National Park*

To supplement the main protected areas, Taiwan has identified and/or created a wide range of nature reserves, wildlife refuges, wildlife habitats, forest reserves. Bird watchers would be delighted to learn that these include localities such as Guandu Nature

Park in Taipei, the Mianhua (Mienhuahsu), and Huaping (Huapinghsu) Islands, the Penghu County Cat Islet Seabird Refuge, and the Matsu Islands Wildlife Refuge as well as an extensive array of wetland reserves.

Taiwan features some 18,400 species of wildlife of which about 20% are considered rare or endangered.

TAIWAN'S CULTURAL HERITAGE

The aboriginal cultures (12 aboriginal tribes) of Taiwan represent 2% of the population of the island. Taiwan also has more than 5,000 temples (Buddhist, Taoist and Confucius), ranging in size from single room shrines to vast multi-story complexes. Taiwan's cultural history includes elements resulting from previous Portuguese and Japanese occupation.

The National Palace Museum in Taipei holds one of the largest collections of Chinese artifacts and artworks in the world, additionally most of the items were collected by China's ancient emperors. In addition, near Taipei, the excellent Shihshang Museum of Archaeology focuses on research, conservation, collection and display of cultural artifacts of Taiwan's indigenous people unearthed at the Shihshang excavation site and dating back some 500 to 1800 years to Taiwan's prehistoric time.

Taiwan is an excellent shopping destination, with everything from ultra-modern shopping malls to traditional markets (including 'night markets').

SUMMARY – TAIWAN'S EXPERIENTIAL TOURISM FEATURES

1. Outstanding ecotourism and geotourism features related to Taiwan's recent volcanic and tectonic history, with particular reference to the following three key reference sites i.e.

- Yangmingshan National Park,
- Turtle (Guishan) Island forming part of the Northeast and Yilan Coast National Scenic Area and designated as part of the Northern Coast Geopark,
- Penghu Marine Geopark,

and incorporated with visits to any of the following outstanding experiential attractions.

- National Palace Museum in Taipei.
- Other national parks, particularly the world-famous Taroko National Park, renowned for its nearly vertical marble gorge, one of the most astounding

landscapes in the world. Taroko is also the home of the indigenous Truku people.

- Also Yushan National Park, the largest national park in Taiwan, located on the central part of the island. It contains Jade Mountain (Yushan literally means "Jade Mountain", 3952 m high) which is the highest peak in East Asia.
- North Coast and Guanyinshan national scenic area, particularly the spectacular Yehliu coastal landforms within the Yehliu Geopark and the Shihsanhang Museum of Archaeology, and other parts of the Northeast and Yilan coastal landforms, which together form the balance of the designated Northern Coast Geopark (Figure 13.4).
- Designated Liji, Yangchao, and Caoling Geoparks.
- Guandu Nature Park (Taipei).
- Jinguashi Gold Ecological Park (Rueifang, Northern Taiwan).
- Alishan National Scenic Area including the famous Alishan Forest Railway.
- Sun Moon Lake National Scenic Area.
- Green Island (Latou).
- Chung Tai Chan Monastery (Nantou), Fo Guang Shan Monastery (Kaohsiung), Dharmas Drum Mountain (new Taipei City), Tzu Chi Temple (Kaohsiung), the world famous Juming Sculpture Museum (Jinshan).
- Night Markets of Taipei.
- Seasonal Lantern Festival, Aboriginal Celebrations, Matsu Festival, Taiwan International Orchid Show and other outstanding cultural events.



Figure 13.4 *Yehliu Geopark's famous trademark Queen's Head - mushroom (wind erosion) of sedimentary rocks*

2. Cultural, religious and historical themes with indigenous, Chinese, Japanese and European influences. Taiwan has its own cuisine, but has also embraced the best of mainland Chinese cooking. Visitors to Taiwan can experience Chinese food from all of the key cuisine regions of Mainland China.

Getting around Taiwan is very easy. With excellent inter-city air, rail and bus services, Taiwan is also served by the Taiwan High Speed Rail service that runs approximately 345 km along the west coast of Taiwan, from the national capital of Taipei to the southern city of Kaohsiung. Taxi services are also excellent and very low cost by world standards. Taiwan's tourism infrastructure is robust with much detailed information including maps for the national Taiwan Tourism Bureau which is supported by visitor information centres in all regional centres.

OUTSTANDING ECOTOURISM AND GEOTOURISM FEATURES RELATED TO TAIWAN'S RECENT VOLCANIC AND TECTONIC HISTORY

Yangmingshan National Park

Located very close to Taipei, Yangmingshan National Park is the smallest and northernmost national park of Taiwan. Yangminshan is famous for its hot springs and geothermal activity. Each spring, Yangminshan also has a dazzling flower season.

Whilst casual access into the tourist fumarole areas is easily achieved, the Yangmingshan National Park trail system can be utilised for a more extensive experience as the mountain peaks are accessible by a network of maintained hiking trails. For example, one long trail of some 8.5 km in length extends through Dingshan, Shihtiling, east peak, the main peak of Qixing Mountain (Chixingshan), the main peak, south peak and west peak of Datun Mountain (Datunshan), Miantianshan and Xiangtianshan among others. Enriched by andesite, Datun Mountain's conic or bell-shaped volcano body, crater and volcano lakes provide a unique geological terrain in the area. Hot springs and steam vents are mainly found along the Jinan Fault Zone between Baotou and Jinan, some 18 km long and 3 km wide. The most active steam vents are those at Tahuangtsui, Xiaoyoukeng, Macao, Dayoukeng, Ssuhuangtzuping and Kengtzuping. It is suggested that 1-2 days is allocated for the entire trip, which may be taken in different legs of 1/2 to 1 day each. (Source: Yangmingshan National Park Headquarters website).



Figure 13.5 Steam vent area, Xiaoyoukeng, Yangmingshan National Park

Turtle (Guishan) Island

Named for its similarity to the shape of a floating turtle, whilst Turtle Island is a well known landmark just off the coast of Taiwan, it is not a place well frequented by Taiwanese. The island is only open to tourists from 1 March to 30 November. The island is 3.3 km wide from east to west and 1.7 km long and reaches a maximum elevation of 401 m. Comprised almost entirely of andesite, strongly altered by sulphurous hydrothermal activity, the island features steep cliffs, active hot springs, erosional caves, lakes, cold springs, and rare cliff vegetation surrounded by a rich ocean ecosystem situated in streaming warm water fed by the undersea fumaroles. Of particular interest is the opportunity to see spinner dolphins, bottle-nosed dolphins, small killer whales, and false killer whales - the best season for this activity is April through the end of August. Tours can be arranged to either engage in the wildlife watching and/or to actually visit the island by ferry and explore its landscape and its built heritage. There are restrictions on visitation because of its status as a marine ecological park and visitor applications need to be made in advance of any intended visit.



Figure 13.6 *Aerial view of Guishan Island showing undersea fumaroles on the right hand side of the island*



Figure 13.7 Profile of Guishan Island showing hydrothermal alteration of andesite

Penghu Marine Geopark

The Penghu Marine Geopark, an archipelago comprising 64 islands and islets, lies off the western coast of Taiwan. These islands and islets are mainly formed by basalt lava flows and a partly sedimentary rock sequence produced by intermittent eruption and weathering episodes (Lin, 2009). The islands feature many attractive volcanic landforms including unusual columnar basalt jointing.

Lin, 2009 has documented the key basalt geosites which include the following highlights:

- Jibei Island (Jibeiyu) – includes many fine stone weirs or fishing traps constructed from basalt and coral reef material that has become a distinguishing cultural feature of Penghu. There are some 590 stone weirs in Penghu, of which about 100 are located on this island.
- Siaomenyu - includes the unique ‘whale cave’, 10 beautiful stone weirs, and the Siaomen Geology Gallery.
- Kueibishan and Chihyu – tholeiite basalts with sea cave and sea stack erosional features.
- Tongpanyu – well known for its ‘lotus platform’ and basaltic columnar joint cliffs and platy jointing.
- Wang-an – the largest island in Penghu features tholeiite xenoliths and outstanding coastal erosional features.
- Qimei (Cimei) – features pyroclastic deposits and iconic ancient fish traps.



Figure 13.8 *'Twin Hearts' Basalt Fish Trap, Cimei Island*

Various interesting geomorphological features can also be seen within islets forming part of the Penghu South Basalt Nature Reserve (Dongjiyu, Sijiu, Toujin and Tiejhan), the Penghu Columnar Basalt Nature Reserve (Chishanyu, Tingkoyu and Hsiaobaishayu), the North Sea islands (Yuanbeiyu, Siaobaisha and Niao) and others, notably Tongpan, Yuanbei, Hujing and Mao islets.



Figure 13.9 *Classic Penghu Basalt Columnar Jointing, Tongpan Islet*



Figure 13.10 *Sloping Basalt Columnar Jointing, Yuanbei islet*

The main island of Magong City/Huxi Township features the Penghu Marine Geopark Centre which exhibits both the diverse basalt landscapes and the cultural use of basalt in Penghu Island. Penghu also abounds in rich biodiversity including marine (including turtles), birdlife and unique plant species, information about which can be found in a wide range of visitor centres.

Penghu can be accessed by daily flights from Taipei Songhsan Airport for Magong City from where tourist boats leave daily (but not in the winter months) for visits to the various islands which usually include stops on Qimei, Wang-an and Tongpanyu islands.

CONCLUSIONS

Not well known for its nature-based tourism potential, Taiwan is one of the world's best kept secrets for experiential tourism and is an important destination in the global network of countries with volcanic experiences. The extensive and unusual geodiversity of volcanic landforms and the inter-relationship of this geology and geomorphology with cultural heritage in the Penghu Marine Geopark, as well as the undersea fumaroles at Turtle (Guishan) Island as a site for whale and dolphin watching are truly unique experiences. The proximity of 'calm' volcanic activity within Yangmingshan National Park located on the outskirts of a major global city is also cause for reflection.

ACKNOWLEDGEMENTS

The support and contributions by way of supplementary photographs and diagrams by Professor Jiun-Chuan Lin of the Department of Geography, National Taiwan University and the Geographical Society of Taiwan is gratefully appreciated. Photos (figures 3, 4, 7 & 10) have been contributed by Angus M Robinson.

REFERENCES

Central Geological Survey of the Ministry of Economic Affairs.
http://www.moeacgs.gov.tw/english/twgeol/twgeol_generalgeol.jsp

Lin, Jiun-Chuan ‘2009 East Asian Geoparks – Vision, Problems and Prospects’:
Proceedings of the East Asian Geoparks Conference.

Lin, Jiun-Chuan (2009) ‘The Geodiversity of the Penghu Marine Geopark’:
Proceedings of the East Asian Geoparks Conference, pp 315-326.

Lin, Jiun-Chuan (2009) ‘Geopark at Northeast and Yilan Coast National Scenic Area’:
*The Bitou Cape-Longdongwan Geopark Guidebook. Department of Geography,
National Taiwan University.*

Liu, Shu-Ling (2009) ‘Penghu Marine Geopark-Culture & Travel Volume’: *Agriculture
and Fisheries Bureau, Penghu County Government.*

National Geographic (2005) Geotourism Charter.

www.nationalgeographic.com/travel/sustainable/pdf/geotourism_charter_template.pdf

National treasure: protected areas in Taiwan (2007): *Forestry Bureau, Council of
Agriculture, Executive Yuan.*

Taiwan Islands Net, a website for island studies at Graduate Institution of
Environmental Education, National Taiwan Normal University.

The Beauties of Taiwan, Penghu National Scenic Area (2005): *Penghu National Scenic
Area, Tourism Bureau, MOTC.*

Tsai, Li-Chiu & Lin, Chang-Hsing (2008) ‘The Story of Siaomenyu’: *Penghu Geopark
Series, Agriculture and Fisheries Bureau, Penghu County Government.*