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News and Highlights

IUGS released first 100 Geological Heritage Sites and China has seven in the list

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On October 26, 2022, the International Union of Geological Sciences (IUGS) unveiled the First 100 IUGS Geological Heritage Sites in Spain. These sites are located in 56 countries, including 34 in the Americas, 28 in Europe, 15 in Africa and 23 in the Asia-Pacific-Middle East region (Table 1). The seven selected sites of China are introduced as follows (black font in Table 1).

1. Ordovician Rocks of Mount Qomolangma (China and Nepal)

The Himalayas have a unique ecosystem, which records the evolution history of the earth's land and sea changes, and contains extremely rich mineral resources and biodiversity resources. The Ordovician rocks are located on the summit of Mount Qomolangma (Fig. 1). They are made of limestone from the Middle Ordovician about 460 Ma years ago and formed in a warm, shallow ocean. These rocks contain the fossils of a variety of Marine animals, such as brachiopods, conodont and echinoderm crinoids, representing tropical Marine life from one of the most important periods in Earth's history, the Great Ordovician Biodiversification Event (GOBE), which is now mostly extinct or rare. Deposited in an ancient Tethys Ocean, these rocks were thrust and uplifted into their present commanding position when Indian collided with the Asian continent. Research is ongoing that will hopefully reconstruct the geological history of the area.

2. National geological heritage protection area “Permian-Triassic great extinction and GSSPs of Meishan, Changxing County, Zhejiang Province”

The Meishan D section in Changxing County, Zhejiang

Province contains two GSSPs including base of the Permian-Triassic boundary and the base of Changxing Stage, which completely records the biggest mass extinction event in geological history 252 Ma years ago on Earth (Fig. 2). The strata in Meishan D section are continuous and contain abundant paleontological fossils. Studying the mechanism of these major events has important implications for assessing the current situation of the earth ecosystem and predicting the future development trend. The ash beds of the Meishan sections have been used as a natural laboratory for refining high-precision geochronologic dating in the past 20 years, and has made important contributions to promoting the study of mass extinction events in the field of geological sciences and the construction of the international chronostratigraphic chart.

3. World Natural Heritage Site and National Geopark “Cambrian Chengjiang Fossil Site and Lagerstätte”

About 520 Ma years ago, the Cambrian Chengjiang Fossil Site in Yunnan Province is a rare treasure house of fossils, representing the real face of the Marine life world at that time (Fig. 3). In 2012, Chengjiang Fossil Site-Maotianshan Mountain in Chengjiang, Yunnan Province and its surrounding areas were officially named World Natural Heritage Site, which is the first fossil World Natural Heritage Site in China and the only one in Asia. The Cambrian Chengjiang Fossil Site demonstrates the biodiversity of the Early Cambrian, representing the starting point of modern biodiversity. The evolutionary history of most modern animal groups can be traced back to the Early Cambria, providing valuable evidence for revealing the mystery of the Cambrian explosion.

4. Early Cretaceous rhyolitic columnar pock formation of Hong Kong

The Early Cretaceous Rhyolitic Columnar Rock Formation in Hong Kong Global Geopark originates from

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Table 1. First 100 Geological Heritage Sites.

No.	Name	Country/Region	No.	Name	Country/Region
1	Siccar Point (Hutton's Unconformity)	United Kingdom	51	The Danakil Rift depression and its volcanism	Ethiopia and Eritrea
2	The Quaternary Phlegrean Fields volcanic complex	Italy	52	The Quaternary Cameroon Volcano	Cameroon
3	Mohorovičić discontinuity at Gros Morne National Park	Canada	53	The historic scoria cone of the Jabal Qidr	Saudi Arabia
4	The Holocene Puy-de-Dôme and Petit-Puy-de-Dôme volcanoes	France	54	The Pleistocene Kilimanjaro Volcano	Tanzania
5	The Paleocene volcanic rocks of the Giant's Causeway and Causeway coast	United Kingdom	55	The Holocene Ulmen maar	Germany
6	Funafuti Atoll	Tuvalu	56	The 1905-1911 Matavanu volcanic eruption	Samoa
7	Capelinhos volcano	Portugal	57	The active Yasur–Yenkahe volcanic complex	Vanuatu
8	Taburiente volcanic Caldera in La Palma Island	Spain	58	La Isla de Ometepe: Quaternary volcanoes in the Lake Nicaragua sedimentary basin	Nicaragua
9	Quaternary glacial varves of Ragunda	Sweden	59	The Poás Volcano	Costa Rica
10	Genbudo Cave	Japan	60	The Nevado del Ruiz Quaternary Volcanic Complex	Colombia
11	GSSP for the Silurian-Devonian boundary at Klonk Hill	Czech Republic	61	The Cotacachi - Cuicocha volcanic complex	Ecuador
12	Archean Barberton Greenstone Belt	South Africa	62	The Quaternary Santorini Caldera	Greece
13	Paleoproterozoic Banded Iron Formation of the Quadrilátero Ferrífero	Brazil	63	The vapor phase ignimbrites of Sillar in the Añashuayco Quarries of Arequipa	Peru
14	Glacial record of the Marinoan snowball Earth	Namibia	64	The Calicanto pyroclastic succession of the 1600 CE Huaynaputina eruption	Peru
15	The Cambrian Explosion in Sirius Passet	Greenland	65	The Miocene Cappadocian Ignimbrites sequence	Turkey
16	The Great Unconformity at Grand Canyon	USA	66	El Tatio geothermal field	Chile
17	The Ordovician rocks of the Mount Qomolangma	China and Nepal	67	The Yellowstone volcanic and hydrothermal system	USA
18	Permian-Triassic great extinction and GSSPs of Meishan	China	68	Ynys Llanddwyn late Neoproterozoic-Cambrian Mélange	United Kingdom
19	Carboniferous – Triassic Unconformity in Telheiro	Portugal	69	Namakdan Salt Cave	Iran
20	Cretaceous to Paleogene stratigraphic section of Bottaccione Gorge, Gubbio	Italy	70	The Moine Thrust Zone	United Kingdom
21	Cretaceous-Paleogene transition at Seymour (Marambio) Island	Antarctica	71	Upper Jurassic ophiolitic sequence in La Désirade Island	France
22	Cretaceous – Paleogene stratigraphic section of Zumaia	Spain	72	The South Tibetan Detachment System in the Rongbuk Valley	China
23	GSSP of the Meghalayan Stage in the Mawmluh Cave	India	73	Northern Snake Range metamorphic core complex	USA
24	Ediacaran fossil site of Mistaken Point	Canada	74	Nojima Fault	Japan
25	Ediacaran fossils in the Ediacara Hills, Flinders Ranges, Australia	Australia	75	Tsumeb Ore Deposit	Namibia
26	Cambrian Chengjiang Fossil Site and Lagerstätte	China	76	The giant mercury deposit of the Almadén syncline	Spain
27	Burgess Shale Cambrian Palaeontological Record	Canada	77	Deposits of Amethyst of Los Catalanes Gemological District	Uruguay
28	Ordovician Fezouata Shale fossil site at JbelTizagzaouine	Morocco	78	Uluru inselberg	Australia
29	Middle Ordovician giant trilobites of Canelas quarry	Portugal	79	The Sugar Loaf monolith of Rio de Janeiro	Brazil
30	Devonian Tetrapod Trackways of Holy Cross Mountains	Poland	80	Shilin Karst	China
31	“Coal Age” Joggins Fossil Cliffs	Canada	81	Tsingy of Bemaraha	Madagascar
32	Late Permian Tete Fossil Forest	Mozambique	82	La Puerta del Diablo inverted relief	El Salvador
33	The Ammonite Slab of Digne-les-Bains	France	83	Quaternary interglacial coral and marine uplifted terraces of Maisí, Cuba	Cuba
34	Jurassic Solnhofen-Eichstätt Archaeopteryx Serial Site	Germany	84	The Grand Canyon	USA
35	Marine Reptile Lagerstätte from the Lower Cretaceous of the Ricaurte Alto	Colombia	85	Iguazú/Iguaçu waterfalls	Argentina and Brazil
36	Dinosaur Provincial Park	Canada	86	Mosi-oa-Tunya/Victoria Falls	Zambia and Zimbabwe

Table 1. (Continued)

No.	Name	Country/Region	No.	Name	Country/Region
37	Late Cretaceous rudist bivalves of the Caribbean Province	Jamaica	87	Dry Falls and the Channeled Scabland	USA
38	Eocene paleontological record of Messel Pit Fossil Site	Germany	88	Jutulhogget Canyon	Norway
39	Miocene primates paleontological site of Napak	Uganda	89	Perito Moreno Glacier	Argentina
40	Lesvos Early Miocene Petrified Forest	Greece	90	Rockglaciers of the Engadine	Switzerland
41	Palaeoanthropological Sites of Human Evolution of Laetoli – Olduvai Gorge	Tanzania	91	The Okavango Delta	Botswana
42	Late Quaternary asphalt seeps and paleontological site of La Brea Tar Pits	USA	92	Yardang (Kalut) in the Lut Desert	Iran
43	Archean Zircons of Erawondoo Hill	Australia	93	Namib Sand Sea	Namibia
44	The Hadean to Eoarchean Nuvvuagittuq greenstone belt	Canada	94	Bilutu megadunes and lakes in the Badain Jaran Desert	China
45	Archean Rocks of the Eastern Beartooth Mountains	USA	95	Vajont landslide	Italy
46	The Stillwater Complex	USA	96	Pamukkale Travertines	Turkey
47	Early Cretaceous Rhyolitic Columnar Rock Formation of Hong Kong	China	97	Puquios of the Llamara salt flat	Chile
48	Richat Structure, a Cretaceous Alkaline Complex	Mauritania	98	Škocjan Caves in the Classical Karst	Slovenia
49	The Miocene Torres del Paine intrusive complex	Chile	99	Sac Actun Underwater Cave System	Mexico
50	Mount Kinabalu Neogene Granite	Malaysia	100	Domo de Araguainha Impact Structure	Brazil



Fig. 1. Ordovician rocks of Mount Qomolangma, Tibet (source: <https://news.sciencenet.cn/htmlnews/2022/10/488289.shtml>).

volcanic activity in the area about 140 Ma years ago (Fig. 4). The Columnar Rock Formation is widely exposed along the coast, cliffs and numerous islands in Sai Kung. The formation occurs as a wide-spread sheet of about 100 km² and up to 400 m in thickness in a giant caldera complex. The average column diameter is 1.2 m, with the largest specimens measuring 3m. Sai Kung is characterised by long meandering coastlines and numerous islands. This formation is integrated with diverse coastal erosion and deposition landforms, such as sea cliffs, sea notches, sea caves, sea arches, sandy and pebble

beaches. The site presents a rare geomorphological landscape.

5. The South Tibetan detachment system in the Rongbuk Valley

The South Tibetan Detachment System in the Rongbuk Valley is a group of ductile shear belts with low angle normal faults parallel to the Himalayan Orogenic Belt, extending along the entire strike of Himalaya, located on the north slope of Mount Qomolangma (Fig. 5). The upper reaches are



Fig. 2. Permian-Triassic great extinction and GSSPs of Meishan, Zhejiang Province (source: <https://news.sciencenet.cn/htmlnews/2022/10/488289.shtml>).



Fig. 3. Cambrian Chengjiang fossil site and lagerstätte, Yunnan Province (source: <https://news.sciencenet.cn/htmlnews/2022/10/488289.shtml>).



Fig. 4. Early Cretaceous rhyolitic columnar rock formation of Hong Kong (source: <https://news.sciencenet.cn/htmlnews/2022/10/488289.shtml>).

Rongbuk Glacier Valley, which is the largest glacier and ice forest in Mount Qomolangma, and the lower reaches are Rongbuk Valley. Its discovery completely changed the model of the Himalayan Orogenic Belt and greatly improved the understanding of the tectono-metamorphic evolution of the Himalayan Orogenic Belt. Rongbuk Valley is a typical area for the development of diolitic system in South Tibet, which

has important scientific value.

6. Shilin karst

Shilin Karst is a site of plateau karst, outstanding for the limestone pinnacles decorated with deep, sharp karren, which is the result of karst processes (Fig. 6). The limestone is



Fig. 5. The South Tibetan detachment system in the Rongbuk Valley, Tibet (source: <https://news.sciencenet.cn/htmlnews/2022/10/488289.shtm>).

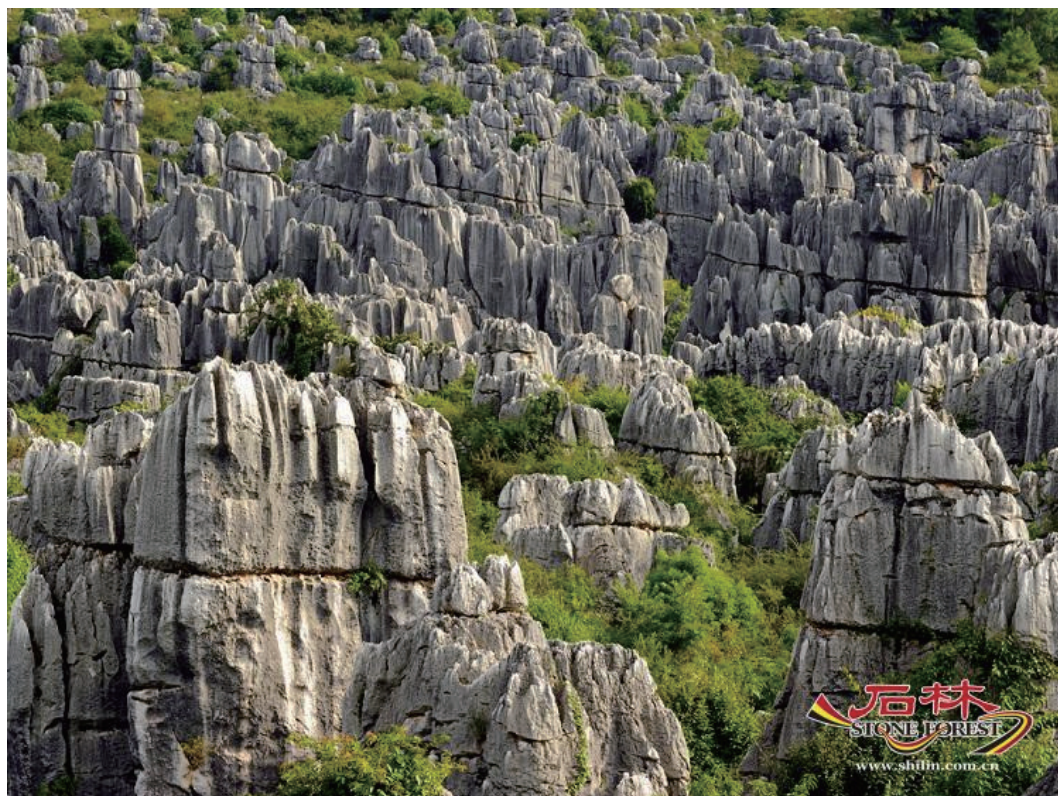


Fig. 6. Shilin karst, Yunnan Province (source: <http://www.chinastoneforest.com/public/protal/zh-CHS/detail-164-538.html>).

overlain by red Paleogene sandstone and Permian basalt. Shilin exhibits pinnacle shaped karst and other representative karst landforms such as doline, karst cave, depression, karst lake, natural bridge and waterfall, which not only enrich the aesthetic characteristics and values of karst in southern China, but also show the complex evolution history of karst landscape in southern China, known as the “Shilin Karst Museum”.

7. Bilutu Megadunes and Lakes in the Badain Jaran Desert

Covering an area of 49200 km², the Badain Jaran Desert hosts the unique megadune-lake system in the world (Fig. 7). The Bilutu Sand Peak and its surrounding lakes are typical examples of this system. There are many giant sand mountains distributed in the site, and more than 140 lakes, the highest Bilutu Sand Peak about 1611 m above sea level, the relative height difference of nearly 500 m, is the world's highest relative height megadune. The Badain Jaran Desert is an ideal area to study the climatic changes, wind

geomorphology and water resources in arid areas during the Late Quaternary of the uplift of the Qinghai-Tibet Plateau.

IUGS Geological Heritage Sites are key area with geological relics/geological processes of international significance, which can be used as a global comparison standard or a place of extraordinary significance in the history of the development of geological sciences, representing that the geological heritage site has the highest international geological value and research level, and has been effectively protected. Most of the seven geological heritage sites in China are previously recognized world or national geoparks or geological heritage reserves. They receive a large number of visits every year and play an important role in publicizing scientific knowledge about the livable earth, the formation of mineral resources, the evolution of life and the origin of human beings.

Source: People's Daily, November 2, 2022, https://paper.people.com.cn/rmrb/html/2022-11/02/nbs.D110000renmrb_13.htm; The First 100 IUGS Geological Heritage Sites Dossier, https://www.iugs.org/_files/ugd/f1fc07_af0231893ea04e61986d7aaf92cc085a.pdf?index=true.



Fig. 7. Bilutu Megadunes and Lakes in the Badain Jaran Desert, Inner Mongolia (source: <https://news.sciencenet.cn/htmlnews/2022/10/488289.shtm>).