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THE EARLIEST CHINESE KARSTOLOGIST XU XIAKE

PRVI KITAJSKI KRASOSLOVEC XU XIAKE

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Abstract

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Nataša Ravbar: The earliest Chinese karstologist Xu Xiake

The first real scientific exploration of karst and karst caves in south China was undertaken by Xu Xiake (1587 - 1641). Chinese karst was studied by Xu Xiake for more than thirty years. He described his journeys to almost half of the territory of the Ming dynasty in his book »Xu Xiake's travels« (»Xu Xiake youji«), that was first published in 1642. He dedicated a lot of time to the research of the underground world by describing subterranean rivers and lakes as water resources. He also made ground plans of some caves, marked their entrances and described different shapes of speleothems. He first described different ways of climbing in caves and methods for cave research. Altogether he visited over 300 caves. Xu Xiake first described different types of the tropical karst and focused on the characteristics and reasons of the tower hills origin. He introduced the term *fenglin* (peak forest), which is still used in the scientific literature. However, he is not only the father of the modern speleology, karstology, geomorphology and geography in the Chinese scale but in a worldwide sense.

Key words: history of karstology, history of speleology, Xu Xiake, China.

Izveček

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Nataša Ravbar: Prvi kitajski krasoslovec Xu Xiake

Prvega pravega znanstvenega raziskovanja krasa in jam na območju južne Kitajske se je lotil Xu Xiake (1587 - 1641). Kras je proučeval več kot trideset let ter obiskal preko 300 jam. Svoja popotovanja po skoraj polovici ozemlja tedanjega kitajskega cesarstva je opisal v knjigi »Xu Xiakejeva potovanja« (»Xu Xiake youji«), ki je bila prvič objavljena leta 1642. Velja za najzgodnejše razprave o krasu in je napisana v obliki dnevnih zapiskov. Opisal je podzemne reke in jezera, vodne vire, narisal je tlorise nekaterih jam in zabeležil njihove vhode ter opisal različne oblike speleotemov, načine plezanja po jamah in metode raziskovanja jam. Prvi je opisal različne tipe tropskega krasa ter se osredotočil na značilnosti in vzroke nastanka stolpastih vzpetin. V literaturo je vpeljal izraz *fēnglín* (gozd vrhov). Zato Xu Xiake ni oče moderne speleologije, krasoslovja, geomorfologije in geografije le v kitajskem merilu, temveč tudi v svetovnem.

Ključne besede: zgodovina krasoslovja, zgodovina speleologije, Xu Xiake, Kitajska.

KARST IN CHINA

China has the largest karst areas in the world. They are so diverse that one can find almost all sub-types of the karst phenomena there. The areas of carbonate rock extend over one seventh of the state territory, which makes up to 1.250,000 km² (Zhang 1980; Yuan 1991; Sweeting 1995), and amounts to approximately one fourth of all carbonate rock areas in the world.

Karst areas are developed from the coral reefs at the 7° N up to Xiao Hinggan mountains at the 48° N, from Pamir at the 74° W to the Taiwan islands at the 121° E. Karst surface expands from the atolls of the South China sea up to the high mountains and plateaus of Tibet and Himalayas. The most distinct features are on the Shanxi province plateau on the north and on the Yunnan-Guizhou Plateau on the southwest of the country (Yuan 1991).

The most important karst types in China are tropical and subtropical karst in the south and southwest of China, karst in the temperate semi-arid region in the north, and high mountain and plateau karst in the west of China. In addition there is coastal and isolated karst in the dry temperate and humid temperate belt.

The most widely developed karst phenomena lie within the provinces of Yunnan, Guizhou and Guangxi in the southern and southwestern part of China, where tropic and subtropic karst prevail. This area covers more than 320,000 km². The main landscape features in the tropic and subtropic monsoon climate are cones and pillars, rising over the alluvial valleys, plateaus with deep river canyons among them, sharp karrens in stone forests, terra rosa, long caves and large speleothems. Karst of the temperate semi-dry climate in the north stretches in the provinces Shanxi, Hebei, western Henan, central Shandong and west of the Weihe River in the Shaanxi province, and is normally covered by loess. Alpine karst and plateau karst appear on the Tibetan (Qinghai-Xizang) plateau and surrounding hills in the western Sichuan and Yunnan province and also in the Kunlun Mountains. Karst features appear above the upper forest line at the elevation of 4,000 - 5,000 meters (Yuan 1991; Sweeting 1995).

THE HISTORY OF KARST RESEARCH

THE CHINESE AND WESTERN KNOWLEDGE ABOUT KARST UNTIL THE 17th CENTURY

The beginning of the development of the Chinese civilization in what is today called Chinese territory, in Chinese Zhongguo (the country of the middle), goes back to the Neolithic age, when the settlements in the Huang He valley started. Although, the region of the southern China, where the vastest karst areas appear, was colonized later than the central part between the rivers Chang Jiang and Huang He, the karst phenomena were known very early (Yuan 1991; Sweeting 1995). The people were inhabiting the karst caves already in early prehistoric times and have left many traces there. People used to live in caves because of convenient local climate and protection. However, caves were less attractive for the people in the tropics than for those living in the temperate and arid climate.

Discoveries of human remains in the caves are important material evidences about human development. They were protected against decomposition and outer impact by the constant cave

climate and cave sediments. Many archaeological sites of *Sinanthropus* are found near Liuzhou in Guangxi province, in the caves of Yunnan and Guizhou province (Yuan 1991). The ancestor of the Chinese is the so-called Peking man (*Sinanthropus pekinensis*), whose traces originate from the Mindel-Riss period (before 200,000 - 300,000 years ago). The name of Peking man originates from the first archaeological site in a karst cave, called Zhoukou dian cave in the vicinity of Peking, where many skull pieces have been found. First explorations took place in 1924, when the skulls were excavated 70 meters deep below the today's surface. Peking man already knew how to use tools for tilling and how to use fire. Scientists believe that the Peking man lived more than 500,000 years ago. Unfortunately, the original remains, except the teeth, have been secretly lost during the war and only copies remain (Yuan 1991; Sweeting 1995; Kovač 2001).

The caves have always represented holy places, where different cults have been worshiped. Temples and statues in the caves are reported from the whole South and East Asia. This is why

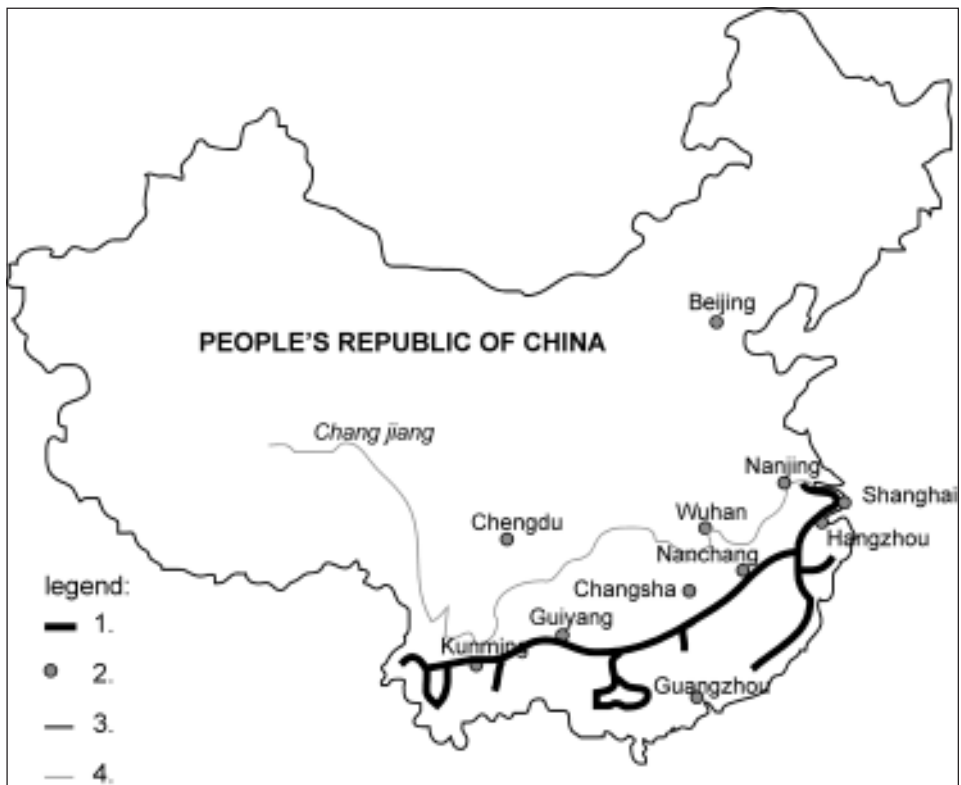


Fig. 1: Map of Jiuyi Mountains in Hunan province was drawn in 168 BC - world's oldest picture of the peak forest and the oldest coloured silk map in China (Xu Xiake yanjiu wenji [Anthology of Xu Xiake's studies] 1986).

Sl. 1: Zemljevid gorovja Jiuyi v provinci Hunan iz leta 168 pr. n. št. - prvi prikaz stolpastega krasa na svetu in hkrati najstarejši barvni zemljevid na Kitajskem, narisana na svilo (Xu Xiake yanjiu wenji [Zbrana dela o Xu Xiakejevih raziskovanjih] 1986).

easily accessible caves are full of cultural objects and coins. Today in some places caves with the flowing water represent sources of drinking water.

Karstology in China has a long tradition. At the beginning the interest for nature and its phenomena prevailed. Special landscape features attracted great attention, but karst as a complex phenomenon was not yet known. A book about the caves in northern China has been written even before 221 BC. In the Mawangdui tomb from Han dynasty (206 BC - 220 AC) a map of Jiuyi Mountains in Hunan province was discovered (Fig. 1). It is most probable, that this map was painted in 168 BC and is the world's oldest picture of the peak forest and also the oldest coloured silk map in China (Ren 1984; Yuan 1991; Sweeting 1995).

In the same time, the ancient Greeks and Romans were already well acquainted with karst phenomenon, both from mythology and everyday life. In the literature karst springs are described very early, because they were important for drinking water supply. Water from the Timavo river springs in the vicinity of Trieste has also been used to provide drinking water for ships that were sailing across the northern Adriatic. They were first mentioned in the 4th century BC, when they were described in the nautical guides. Posidonius (135 - 50 BC) studied them in correlation with the tides and observed the ponor Reka in the Škocjanske jame caves. Virgil (70 - 19 BC) mentioned these springs in his work *Aeneid* as well (Kranjc 1997).

Chinese civilization was one of the first that started irrigating karst poljes and using karst springs for capture (Yuan 1991; Sweeting 1995). Karst springs in northern China were usefully exploited for water supply and irrigation very early, which is evidenced by the records on the turtle shell and bones from the Shang dynasty (16th - 11th century BC). Jinci karst springs in Shanxi province have been used for irrigation in 453 BC and were mentioned in the *Mountain Scripture* that was written in the Warring States Period (475 - 221 BC). It describes many caves, ponors and underground flows, water springs and other karst phenomena (Yuan 1991). The Hongshan spring, southwest of the Taiyuan city in the Shanxi province was used in the Song dynasty (960 - 1279). The rock-sculptured record indicates that the capture of the water was done between 1040 - 1090. The water was used for irrigation of the 15,200 mu (approximately 1013 ha) of tilling land (Yuan 1991; Sweeting 1995). The notes on the cave walls that are in many places covered with sediments are common in whole China since Sui dynasty (581 - 618) until Qing dynasty (1644-1912) (Sweeting 1995).

The beauties of Guilin had been appreciated in the early Qin dynasty (221 - 206 BC), when the first Chinese emperor Qinshi Huang ordered the building of the water channel connecting two rivers - Chang Jiang and Zhu Jiang. Crossroads near Guilin account for the quick development of a small village called Shian until the year 111 BC, to develop into a town. From the times of the Ming dynasty (1368 - 1644) to 1914 Guilin was the capital of Guangxi province as well, but later it was moved to Nanjing (Sweeting 1995). Geographer Li Daoyuan, who has been living in the time of Northern Wei dynasty (386 - 534) has described Li Jiang River, Qixing Shan Mountains and other karst phenomena from this area, such as karst springs, in his book *Shui Qingchu*. He has also visited some caves and in his book he has mentioned cave pearls.

Also cave tourism developed very early in China, as the earliest sources about visiting the cave Qixing dong in the vicinity of Guilin are of the year 590. The natural beauties of Guilin inspired many poets, painters and other artists for centuries. There will never be enough or too much verse and paintings that could describe how spectacular this landscape is. Many national poems sing about "Guilin and Yangshuo being the most gorgeous spot on the Earth". In 827 the

poet Liu Zongyuan explained in rhyme the origin of the peaks that have the shape of bamboo shoots, the origin of the caves at their foot and the origin of stalagmites (Zhu 1988; Sweeting 1995). The book from the Tang dynasty (618 - 907), published in 899, describes many picturesque places and caves near Guilin (Sweeting 1995).

While medieval Europe had fallen asleep from the karst research point of view, and the knowledge of Classical karst was reposing mainly on antique sources, the Chinese were already interested in reasons of karst phenomena appearance. Fan Chengda from Song dynasty was the first to explain the origin of stalactites. In 1175 he wrote: "Milk water in the cave is constantly dripping and at the same time the process of condensation occurs." He also wrote, that stalactites are hollow in the middle and that they are like a goose feather. This explanation is followed by: "Milk covering, white as snow, originates with condensation of stony solution." (Zhu 1988). There were also discussions about cave climate (Sweeting 1995).

The earliest literature describing the wonders of the nature in Shilin stone forest was written in 1382. It was followed by scarce records of the local historical events in that area. In 1614 some research has been accomplished in the Ziyun cave, that had later also been visited by the famous speleologist Xu Xiake (Kranjc & Liu 2001).

THE CHINESE KARSTOLOGIST XU XIAKE

The first real scientific exploration of karst and karst caves in south China had been undertaken by Xu Xiake (1587 - 1641). He was born in Jiangsu province, in a family of intellectuals, which is why he was very well educated and had a fairly easy access to the scientific books.

He lived in the time of Ming dynasty collapse, with widespread corruption in the empire, economic collapse and financial crisis. The court was prodigal, officials corrupt, and workers and farmers discontented because of additional taxes. There was also a nation-wide rejection of the examinations for the officials among the intellectuals. Xu Xiake was not interested in having a career as an official. He decided rather for the exploring and traveling across his own country.

In the year of 1636 he started his four year journey to study thoroughly geomorphologic and underground features of the karst landscape in southern and southwestern China. Accompanied by his servant he visited Zhejiang, Jiangxi, Hunan, Guangxi and Yunnan provinces, where carbonate rocks cover more than 500,000 km² (Fig. 2). Afterwards he became very sick and was forced to return home, where he died the next year.

Chinese karst was studied by Xu Xiake for more than thirty years. As a pioneer of Chinese speleology he had visited over 300 caves, more than any of his predecessors or contemporaries worldwide. He had described his journeys to almost half of the territory of the Ming dynasty in his book »Xu Xiake's travels« (»Xu Xiake youji«), that was first published in 1642. This book is considered as the earliest discussion about karst and was written as daily notes. It represents a diary of his trips, where he has noted all his observations. Beside his speculations about geomorphology, speleology and biology, he described the history of karstology and speleology in China as well. He dedicated a lot of time to the research of the underground world by describing subterranean rivers, lakes, and water resources. He has also made ground plans of some caves, marked their entrances and described different shapes of speleothems. He first described different ways of climbing in caves and methods for cave research.

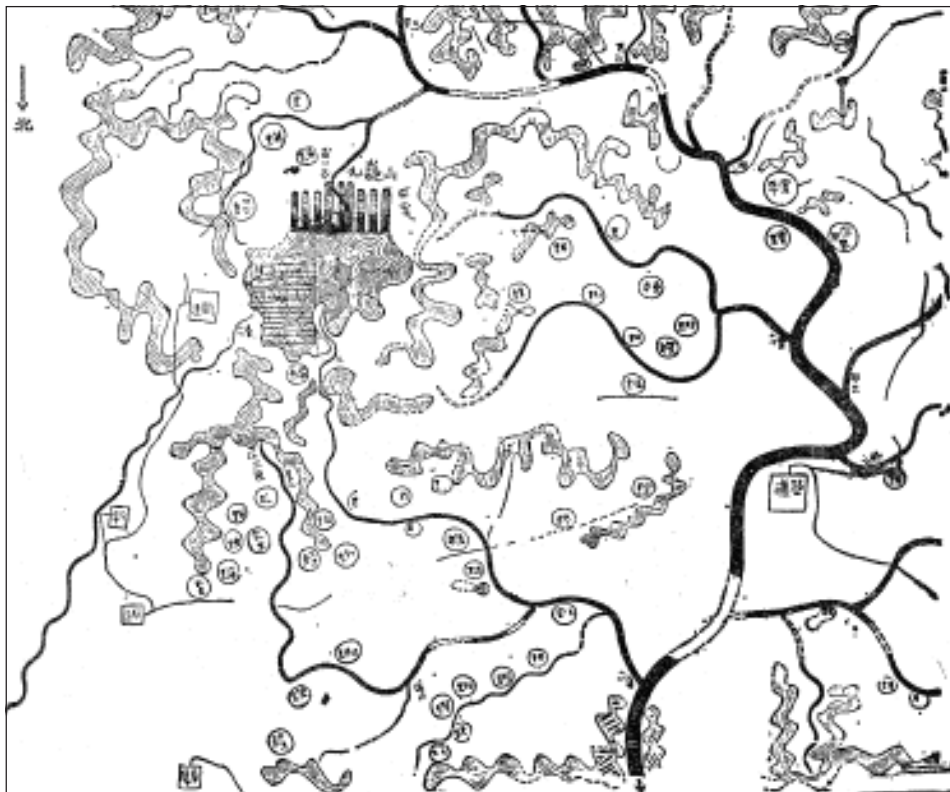


Fig. 2: Xu Xiake's travel in Hunan, Guangdong, Guangxi, Guizhou and Yunnan provinces (based on Microsoft Encarta World Atlas, 1998, drawn by N. Ravbar).

Legend: 1. Xu Xiake's journey, 2. city, 3. country's border, 4. Chang Jiang River.

Sl. 2: Xu Xiakejevo popotovanje po provincah Hunan, Guangdong, Guangxi, Guizhou in Yunnan (na podlagi Microsoft Encarta World Atlas, 1998, sestavila N. Ravbar).

Legenda: 1. Xu Xiakejevo popotovanje, 2. mesto, 3. državna meja, 4. reka Chang Jiang.

Xu Xiake tackled his observations with a great amount of doubt in the interpretations that were used at that time. He was very studious and curious. One can read his notes more as a work of a researcher from the 20th century, than notes of a scholar from the 17th century (Hu 1991). This worldwide masterpiece contains more than 600,000 characters (about 1500 pages) and describes karst geomorphology and caves in south China very carefully. »Xu Xiake's travels« were very accurate for the time of Ming dynasty and presented detailed descriptions of the caves that Xu Xiake had visited. In 1982 the book has been reprinted in classical Chinese (Sweeting 1995).

European research about the karst landscape origin has developed independently of research in China and there have been no contacts between the two. The progress in exploration in the West was reached in the late 15th century, when first descriptions about the underground world from the geographical, geomorphological and geological point of view appeared. These are also

the basic topics of the »Xu Xiake's travels«. However, Xu Xiake is not only the father of the modern speleology, karstology, geomorphology and geography in the Chinese scale, but in a worldwide sense.

Xu Xiake was the first to describe different types of the tropical karst and focused on the characteristics and origins of the tower hills. He introduced the term *fenglin* (peak forest), which is still used in the scientific literature. In 1637 he traveled in the area of Guilin, where he visited more than hundred caves in only 51 days (Sweeting 1995). Xu Xiake described cone hills *fengcong*. *Fengcong* can be translated as peak cluster and is represented by different forms of elevations that rise from the same foundation. They are inter-



Fig. 3: Xu Xiake's statue in front of the Institute for geology of karst in Guilin (Photo: N. Ravbar).

Sl. 3: Xu Xiakejev spomenik pred Inštitutom za geologijo krasa v Guilinu (Foto: N. Ravbar).

Fig. 4: Chinese post stamp, published in 1987 at the 400th anniversary of Xu Xiake's birth.

Sl. 4: Kitajska poštna znamka, izdana leta 1987, ob 400. obletnici Xu Xiakejevega rojstva.

rupted by intermediary depressions, valleys and dolines (Zhu 1988). Already 350 years ago Xu Xiake noted that the stone mountains stretched in the area of south China from Luoping in Yunnan province to Daoxian county in Hunnan province (Yuan 1991). He was also researching population on karst, trying to explain meteorological and climatic phenomena, he introduced karst terminology in the literature and suggested some methods of field research.

Xu Xiake traveled through other parts of China as well. He was particularly interested in river stream and was one of the first that made cross sections of rivers and mountains. He was researching the watershed and river system of the Chang Jiang River and reached its source by following its stream upwards. In the same way he discovered the sources of the Xi Jiang River and proved that the Mekong and the Salween rivers are two independent streams. Xu Xiake's notes are preserved in 16 notebooks, which contain more than 690,000 characters (Yuan 1991; Sweeting 1995). Because he lived almost hundred years before J. V. Valvasor, and because his achievements in many places surmount Valvasor's observations in his »Die Ehre des Herzothums Krain«, Kranjc worthily calls him "Chinese Valvasor" (Kranjc 1987).

Xu Xiake has a high reputation in his country. Many monuments have been set up in his honor, one of which stands in front of the Institute for geology of karst in Guilin and one in front of the Huangguoshu waterfalls in Guizhou province. In 1986-87 at the 400th anniversary of Xu Xiake's birth a symposium in his honor was held in Nanjing.

Even though the karst areas in China cover more than million km², half of which is tropical and subtropical karst in the south of the country, there have been no large and important researches on the karst area done after Xu Xiake until the late 19th or early 20th century. In history this exceptional landscape has delighted mostly poets and painters, who often depicted it. Karst stone pillars with a couple of pines and a pavilion on the top remain one of the main tourist attractions and the subject of the modern investigations.

The karst research in China started to develop in the early 20th century. Even though it has been developing separately from the studies of karst in West, nevertheless many concepts and results are nearly the same.

THE KNOWLEDGE OF CHINESE KARST IN THE WEST

The knowledge of China and its culture has never been easily accessible for us, not only because of the geographical distance and relatively rare contacts in the past, but mainly because of the language barrier. This is the reason Chinese geomorphologists are not able to express their results of research and ideas in a form that would be comprehensible to the wider number of karstologists who belong to other nations. The translations are very unsatisfactory and sparse. Because of the civilization self-sufficient, self-contained Middle Kingdom and difficult access foreign karstologists start to push on very late. It has been mostly *terra incognita* for them; this is why the impressions of one or another have been strongly deformed by their wrong interpretations.

At the beginning of the new era interest in nature and natural phenomena in West has increased again. Classical karst became known in particular, mainly because of the geopolitical situation of that time, when the railway Vienna -Trieste over the Karst was built. Printings had an important role in the popularization of Karst. By the end of the 18th century it has been understood

that limestone solution is basic for karst and afterwards some of the most typical karst areas in Europe were described.

Not before the end of the Chinese - Japanese war at the end of the 19th century and not before the end of revolution in China, foreign scientists have been offered a few opportunities to explore karst areas; especially they have been focusing on the archeological discoveries in the karst caves.

The karst in China, that is still striking special attention with the researchers all over the world, was also described by J. Cvijić in his work "Das Karstphänomen" (Cvijić 1893), even though he himself had never visited this part of karst.

Balazs related in his paper "Beiträge zur Speleologie des Südchinesischen Karstgebietes", that in the period between 1934 and 1938 altogether 86 caves from Asia had been registered, but none of them from China, even though: "on the karst area of south China, cave paradise, is more caves than in whole Europe together!" (Balazs 1962).

Very little has been known in Europe and North America about the conditions and origin of the Chinese karst until the early 70's, which is proved in the book "Important Karst Regions in the Northern Hemisphere" from 1972. The most extensive karst regions in the Northern Hemisphere (including south China) are not even mentioned (Herak & Stringfield 1972; Sweeting 1995).

In the »Atlas des grandes cavités mondiales«, that was published in 1986 and gives one of the best reviews of the cave research worldwide, it is written that the biggest Chinese caves had been visited by the locals hundreds years ago but that systematical cave research, documentation and analyses of the caves is practically unknown in the whole China (Courbon & Chabert 1986). Usually caves were not measured and topographic plans were not made, so as the genetical, geomorphological and chemical features of the underground passages were not made. Much more attention was dedicated to the subterranean biosphere, as well to long history of archeological excavations and researches of the palaeontological remains.

Chinese geomorphologists of the modern era started with the serious exploration of the south China karst in the time of the Japanese occupation in the 30's and 40's of the 20th century, when the headquarters of the state government were moved to southwestern China. Afterwards a quick development of modern karstology followed (Sweeting 1995). The basis for their research were »Xu Xiake's travels«.

CONCLUSION

The first real scientific exploration of karst and karst caves in south China had been undertaken by Xu Xiake (1587 - 1641). In the year 1636 he started his four years journey to study thoroughly geomorphologic and underground features of the karst landscape in southern and southwestern China. He visited Zhejiang, Jiangxi, Hunan, Guangxi and Yunnan provinces, where carbonate rocks cover more than 500,000 km² (Fig. 2).

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PRVI KITAJSKI KRASOSLOVEC XU XIAKE

Povzetek

Prvega pravega znanstvenega raziskovanja krasa in jam na območju južne Kitajske se je lotil Xu Xiake (1587 - 1641). Leta 1636 se je odpravil na štiriletno odisejajo z namenom proučevati geomorfološke in podzemne značilnosti kraškega površja na južnem in jugozahodnem Kitajskem. Obiskal je province Zhejiang, Jiangxi, Hunan, Guangxi in Yunnan, kjer karbonatne kamnine obsegajo več kot 500.000 km² površja (slika 2).

Kitajski kras je Xu Xiake proučeval več kot trideset let in kot pionir kitajskega jamarstva obiskal preko 300 jam. Svoja popotovanja po skoraj polovici ozemlja tedanjega kitajskega cesarstva je opisal v knjigi »Xu Xiakejeva potovanja« (»Xu Xiake youji«), ki je bila prvič objavljena leta 1642. Ta svetovna mojstrovina obsega 600.000 pismenk (okoli 1500 strani) in podrobno opisuje kraško geomorfologijo ter jame na južnem Kitajskem. Opisal je podzemne reke in jezera, vodne vire, narisal je tlorise nekaterih jam in zabeležil njihove vhode ter opisal različne oblike speleotemov, načine plezanja po jamah in metode raziskovanja jam. Knjiga je bila ponovno natisnjena v klasični kitajščini leta 1982 (Sweeting 1995).

Xu Xiake je tudi prvi opisal različne tipe tropskega krasa ter se osredotočil na značilnosti in vzroke nastanka stolpastih vzpetin. V literaturo je vpeljal izraz *fēnglín* (gozd vrhov), ki ga še vedno uporabljamo v strokovni literaturi. Podrobno je opisal tudi stožčaste vzpetine *fēngcóng*, ki se brez reda dvigujejo iz skupne osnove, prekinjajo pa jih depresije (Zhu 1988). Raziskoval je tudi poselitve na krasu, razlagal meteorološke in klimatske pojave, v literaturo je vpeljal kraško terminologijo in predlagal nekaj metod terenskega raziskovanja. Iz tega vidika Xu Xiake ni oče moderne speleologije, krasoslovja, geomorfologije in geografije le v kitajskem merilu, temveč tudi v svetovnem.

Njegovi zapiski so ohranjeni v 16 zvezkih s skupno več kot 690.000 pismenkami (Yuan 1991; Sweeting 1995). Ker je živel nekoliko pred Valvasorjem in ker njegovi dosežki marsikje presegajo Valvasorjeva opažanja v primerjavi s »Slavo Vojvodine Krajnske«, ga Kranjc upravičeno imenuje Kitajski Valvasor (Kranjc 1987).