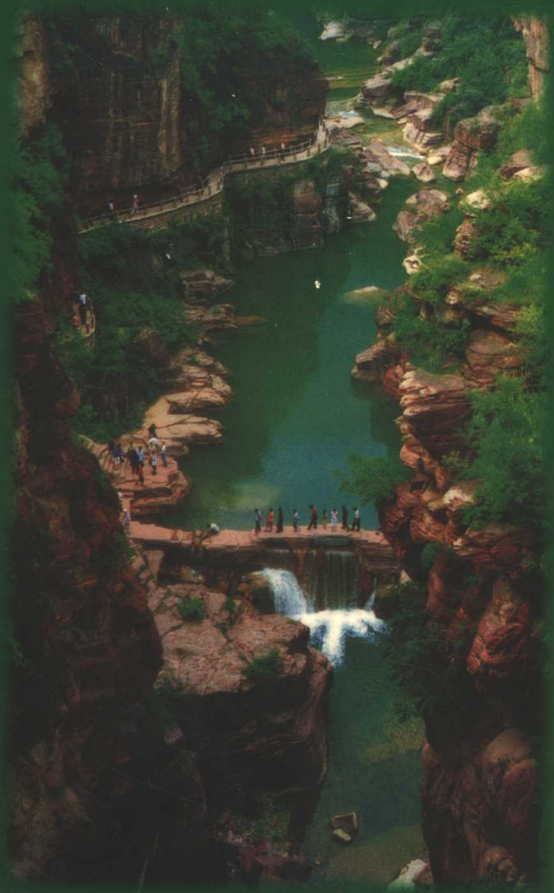
中国云台山世界地质公园规划与建设

Planning and Construction for Yuntaishan World Geopark, China

主编：王建平　叶昭和



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内 容 提 要

本书共收集论文20篇，主要反映中国云台山世界地质公园地质、地貌景观特征、成因背景分析、旅游业发展、规划、建设等方面内容。各位学者专业不同，研究领域各异，各抒己见，汇集成册。

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序

地质公园是以具有特殊地质科学意义、稀有的自然属性、较高的美学观赏价值，具有一定规模和分布范围的地质遗迹景观为主体，并融合其他自然景观与人文景观而构成的一种独特的自然区域。它是地质遗迹景观和生态环境的重点保护区、地质科学研究与普及的基地，也是为人们提供具有较高科学品位的观光游览、度假休闲、保健疗养、文化娱乐的场所。

地质公园有省级地质公园、国家级地质公园，最高级别为世界地质公园（联合国教科文组织批准）。

云台山世界地质公园位于中国河南省焦作市西北部，地理坐标为东经112° 44′ 40″ ～113° 26′ 45″，北纬35° 11′ 25″ ～35° 29′ 40″，整个公园面积556km^2，由云台山、青龙峡、峰林峡、青天河、神农山5个园区组成，是一座在裂谷背景下形成的以地质地貌、水体景观为主，以自然生态和人文景观为辅，集美学价值与科学价值于一身的综合型地质公园。

焦作市是一座因采煤业兴盛而诞生的工业城市，至今已有几百年的采煤历史。进入新世纪之后，由于煤炭资源日益枯竭，焦作市处于城市转型和产业结构调整的关键时期。焦作市政府提出要以本市丰富的山水地质景观资源为依托，以旅游业为龙头带动第三产业发展，把旅游业作为全市经济结构调整重点和新的经济增长点的新思路。2001年，中华人民共和国国土资源部批准云台山地区建立国家地质公园。国家地质公园建成之后，云台山地质遗迹得到切实保护，地质旅游资源得到合理规划与开发。近四年来，旅游产业就业人员从8000人增长到2万余人，旅游收入30亿元以上。2004年“五一”黄金周七天仅云台山园区就接待游客26.38万人，门票收入1509.83万元，两项指标持续保持河南省全省的“五连冠”，在全国假日办监测的99个旅游区（点）门票收入和接待游客人数上均排名第五位（2004年5月12日全国假日办公布），这些被旅游业界称之为“焦作现象”。透过这旅游业的“焦作现象”背后是否还能看到另一个“焦作现象”呢？答案是肯定的。名不见经传的“云台山”，2001年成为国家地质公园，2003年在世界地质公园中国区预选中以名列第三胜出，有人说是地质公园界冲出的一匹黑马，又有人说在一个意想不到的地方出现了意外的惊喜。“焦作现象”、“黑马”、“惊喜”的背后是我们地质工作者的辛勤劳作。是地质工作者辛勤劳作催生了这座工业城市，21世纪的第一个春天，又是地质工作者吹响了保护焦作山水，走可持续发展城市道路的号角，继申报云台山国家地质公园成功之后，再次向世界地质公园发起冲锋，今天我们呈现给读者的“中国云台山世界地质公园规划与建设”就是其中的冲锋曲之一。

2004年的春天，2月13号是一个值得纪念的日子，云台山被联合国教科文组织批准成为世界地质公园。春天是美好的，愿春天永远伴着焦作云台山世界地质公园。

赵 逊

2004年6月16日

Preface

Geopark is a kind of particular natural region with special geo-scientific significance、 rare natural features、higher aesthetics value, and accompanied with other natural landscapes and cultural relics on a certain scale. It is main protection areas for geological relics and ecological environment, base for geological research and its popularization, also a good recreation place for touring and holiday with higher scientific taste.

Geopark is divided into world geopark, national geopark and provincial geopark. The former is the highest rank (approved by United Nations Educational, Scientific and Cultural Organization, UNESCO). Yuntaishan World Geopark lies in north-west to Jiaozuo City, Henan province, stretching between 112°44′ 40″ ~113°26′ 45″ E and 35°11′ 25″ ~35°29′ 40″ N. It covers an area of 556km^2, consists of 5 sections, namely Yuntaishan, Qinglongxia, Fenglinxia. Qingtianhe and Shennongshan. This comprehensive geopark formed under rift setting ,dominated with geological geomorphology and running water, accompanied with natural ecology and relics of residents, combining the charms of both natural science and aesthetics.

Jiaozuo is an industrial city born with its flourishing coal mining. After the turn of the new century, the city faced by the problem to adjust its industrial structure because of its perishing coal resources day by day. So the municipal government put forward tourism as key point and new economic growth point with abundant natural resources as carrier. In 2001, Yuntaishan was approved to be a national geopark by Ministry of Land and Resources P.R.China. Afterwards, the geological relics were actually protected, and geological tourism resources were reasonably planned and developed. During the past four years, tourism employee grew from 8000 to 20000, income up to more than 3 billion RMB. 263.8 thousand sightseers visited the geopark only in Yuntaishan Section in "May Day"goldern week in 2004, the ticket income up to more than 15 million RMB. These two items all leaded the fifth in all over the country. It is referred to as "Jiaozuo phenomenon" by tourism industrial. Through this tourism "Jiaozuo phenomenon", can we see another one? Sure. After the successful application to national geopark in 2001, the unknown Yuntaishan rushed to the third in the application to world geopark in China in 2003. Some people said this is a "black horse" in geopark world, other said it's a unexpected surprise. At the back of "Jiaozuo phenomenon", "black horse" and "surprise", there is geologists' hard work. The first spring of the new century, again the geologists blew the corn for protection Jiaozuo tourism resources and keeping sustainable development direction. Today the book we show to the readers "Planning and Construction for Yuntaishan World Geopark, China" is geologists' another blowing.

The day Feb.13rd,2004 is a memorable one, on which Yuntaishan was approved by UNESCO to be a world geopark. Spring is fine, wish the fine is always with Jiaozuo Yuntaishan World Geopark.

Zhaoxun

6.16.2004

前 言

云台山世界地质公园位于太行山南段，山西高原与华北平原接合部位。大地构造位置处于新生代东亚裂谷系华北裂谷与太行山断隆交界的太行山断隆东南边缘。区内地质遗产丰富，主要出露地层有太古界赞皇群、中元古界蓟县系云梦山组、古生界寒武系、奥陶系中统、石炭系中上统、二叠系下统及第四系；矿产资源有煤、水泥灰岩、粘土矿和铁矿等；地质构造以脆性断裂为主，新构造运动发育，对公园内地貌、山水景观的形成起着重要的控制作用。

1971年以前，为满足国民经济建设对矿产资源的要求，先后有地质、煤炭、冶金及地方地质队伍在该区进行过矿产勘查和区域性地质调查工作。1971～1975年3月，山西省地质局区测队进行了1∶20万晋城幅、陵川幅区域地质测量。1984～1996年，河南省地矿局第二地质队先后进行过1∶5万方庄幅区域地质调查，对中元古界蓟县系云梦山组、寒武系上、中、下统和奥陶系中统进行了层序地层单位划分，初步建立了上述地层间的剖面地层层序；并对焦作市回头山水泥灰岩、冯营水泥配料粘土矿、王窑铝氧灰岩矿区等进行了详细勘查工作。几十年来，工作的重点一直是在寻找更多地矿产资源，为矿业开发服务。

1999年2月，联合国科教文组织正式提出“创建具独特地质特征的地质遗址全球网络，将重要地质环境作为各地区可持续发展战略不可分割的一部分予以保护”的地质公园计划。中国政府对联合国科教文组织的地质公园计划作出了积极响应，2000年中国国土资源部制定了《全国地质遗迹保护规划（2001～2010）》和《国家地质公园总体规划工作指南》。2001年云台山被批准为国家地质公园，之后，云台山的旅游业更加兴旺。2003年中国启动第一批世界地质公园的申报工作，2004年2月13日云台山又被批准为世界地质公园。云台山在地质遗迹保护、创建地质公园的过程中一直走在前列，这其中地质工作者为云台山地质公园的申报、规划、建设等方面做了大量的实际工作。本书所收集的论文是他们对云台山地质、地貌景观、水资源、旅游业发展、规划、建设方面的真知灼见。专业不同，观察研究的角度不同；对同一地质遗迹或现象，也可能仁者见仁、智者见智，我们不求统一，因为地球非常奥秘，需要在争鸣中不断探索。

编者

2004年6月

目 录

地球科学是地质公园建立的基础

赵 逊[1] 赵 汀[2]

1. 中国地质科学院，北京，100037；2. 中国地质科学院矿产资源所，北京，100037

2004年2月13日，联合国教科文组织（UNESCO）在其巴黎总部首次组织了世界地质公园评审，一致通过我国申报的八家地质公园为世界地质公园，与位于英国、法国、西班牙、希腊、爱尔兰、奥地利、意大利等国的十七家欧洲地质公园和三家德国国家地质公园一同成为全球首批世界地质公园。

联合国教科文组织（UNESCO）地学部按照2001年6月UNESCO执行局决定（161 EX/Decisions, 3. 3. 1），应有关国际组织的请求，联合国教科文组织支持其成员国提出的创建具独特地质特征区域为自然公园（也称地质公园）。

2002年4月，UNESCO地学部正式发出世界地质公园网络工作指南（operational Guidelines of Unesco Network of Geoparks），开始接受各成员国的国家地质公园提出的申请。

在世界地质公园工作指南中，明确阐述了地质公园的条件和作用提出了对地质遗迹的保护、地质生态环境的养育、地球科学意义的研究、地球科学普及的开展，对发展知识旅游和科学旅游以促进地方经济的可持续发展、对当地居民的就业提供机会等诸多方面的明确要求，其中尤以地球科学研究和科学普及最为突出。

我国向联合国教科文组织提交的八个世界地质公园申报书也突出了每个候选地的科学意义，也就是本区的地学遗迹在地球演化历史进程中的突出意义以及本区的地球科学研究工作在地球科学史上的地位。一般来说，世界地质公园的科学意义从上述两个方面得到了体现。地质遗迹记录的地质历史演化过程中，特殊事件和重要过程的寻本求源，取得地质科学史中划时代和里程碑性的科学成果的研究基地的形成，既是奠定一个世界级地质公园科学价值的依据，也是确定世界地质公园的重要条件，同时还是地质公园服务社会最重要的资源基础。

中国首批世界地质公园的主要特征：

庐山世界地质公园：位于江西北部，东滨鄱阳湖，襟带长江，面积500km^2，地垒构造抬升形成断块山，山势巍峨，花木繁茂，素湍绿潭，悬泉瀑布，景色宜人。风格各异的楼、宇、亭、台，隐现于崇山峻岭，错落有致，令人有置身国际建筑博物馆之感。20世纪30年代，李四光教授建立的第四纪冰川剖面保存尚佳，冰川遗迹清晰可辨，更有历史文化遗迹融汇青山碧水，中国百年近、现代史的众多重大事件就发生于此，可供人们点评。

石林世界地质公园：

位于云南省，面积400km^2，以碳酸盐峰林地貌为特色景观，由晚古生代浅海相灰岩、白云岩构成，特别是厚层块状碳酸盐岩中发育垂直节理，丰沛的雨水沿裂隙节理下渗、溶蚀，形成各种岩溶地貌，如石牙、溶沟、漏斗、峰林、溶洞和溶蚀盆地等。本区以溶蚀峰林最为壮观，或如柱，或如剑，或如古塔，或如蘑菇，貌似人形，怪兽，千姿百态，高达20~50m，群集如林，望而生义，名为石林。区内彝族风情浓厚，古岩壁画，彝文石刻已有多处发现，游人在欣赏自然美景的同时，接受地方民俗文化的熏陶，韵味无穷。

嵩山世界地质公园：

位于河南省中部，面积450km²。以出露完全的地层剖面和三个前寒武纪构造运动形成的角度不整合地质遗迹而著名，有地史教科书之称。出露有35亿年以来的太古宇、元古宇、古生界、中生界和新生界，是23亿年的嵩阳运动、18.5亿年的中岳运动和5.7亿年的少林运动的命名地。三个角度不整合界面及其上的底砾岩均十分清楚。更兼历史古迹众多，庙宇、道观、佛塔、书院、钟鼓相闻，是中华民族远古文明发祥地之一。地质遗迹和人文景观相映成趣，是旅游热点之一。

丹霞山世界地质公园：

位于广东韶关，面积290km².由红色陆相砂砾岩构成的以赤壁丹崖为特色的一类地貌被称为丹霞地貌，丹霞山便是这一类特殊地貌的命名地。丹霞山位于一个山间盆地中，整体为红层峰林式结构，有大小石峰、石堡、石墙、石柱380多座，主峰巴寨海拔618m，大多山峰在300m~400m之间，高下参差、错落有致、形态各异、气象万千。丹霞山由白垩系红色砂砾岩构成，以赤壁丹崖为特色，看去赤城层层、云霞片片。各种形态、组合的丹霞地貌若千年古堡。丹霞的山石拟人拟物，拟兽拟禽，宛如雕塑大师的艺术杰作，但却无一不是出于大自然的鬼斧神工。

构成丹霞地貌的岩石是形成于距今约7至9千万年的晚白垩世的红色河湖相砂砾岩。在距今约6500万年前，受构造运动的影响，本区产生许多断层和节理，同时也使整个丹霞盆地变为剥蚀地区。距今约2300万年的喜马拉雅运动使得本区迅速抬升。在漫长的岁月中，间歇性的抬升和风化剥蚀作用将本地区塑造得如此秀丽多姿。整个山区保存着茂密的亚热带常绿林，四季郁郁葱葱，碧绿的锦江在丹霞山群峰之间迂回南流，一路翠竹夹岸，林木婆娑，奇石倒映，这一切吸引着无数海内外游客纷至沓来。

五大连池世界地质公园：

位于黑龙江省五大连池市，面积720km²，是保存完好的近代火山群，共14座，其中12座喷发于1200万年~100万年前，2座喷发于公元1791年至1721年。火山锥完整，从火山口中喷出的熔岩流长达10余千米，堵塞河流形成五个串珠状分布的湖泊。熔岩形成千姿百态的造型，喷气口和喷气锥、熔岩隧道，火山弹，熔岩碴堆积而成台地，熔岩的绳状构造，翻花状构造等保存完好，特别是丰富矿泉水的医疗效果，是国内和俄罗斯、日本、韩国等国的游客去而复来的重要原因。

云台山世界地质公园：

位于河南省北部的太行山南麓，焦作市境内，处于华北陆块新生代东亚裂谷系之西北边界断裂附近。该地保存了25亿年漫长地质演化历史的记录，特别自中元古代至早古生代的陆表海石英砂岩、泥质岩和碳酸盐，沉积石炭—二叠纪的海陆交互相和陆相沉积，层序发育完全，岩相多变，化石丰富，特征鲜明。产状水平的地层受三组不同方向的断层、节理切割和丰富地表水流的冲刷侵蚀形成了宏伟的阶状断壁、怪石峋嶙的墙状山脊和沉遂的瓮谷长峡、地貌奇特青幽，瀑布悬泉飞濑植被茂密，生物多样性很有特色。

黄山世界地质公园：

雄踞于皖南山区，面积500km²。属花岗岩峰林景观。黄山以奇峰峭拔、雄峻瑰奇而著称。千米以上的高峰有72座，区内奇峰耸立，青松挺拔，巧石嶙峋，云海浩瀚，温泉喷涌，景观令人称绝。

在距今约1.4亿年前的晚侏罗世地下炽热岩浆沿地壳薄弱的断裂带上侵形成了四期互相交切的

花岗岩体，在距今6500万年前后，黄山花岗岩体发生较强烈的隆升。随着地壳的抬升和来自不同方向的挤压应力的作用，产生出不同方向的节理。侵入岩体及其上的盖层遭受风化、剥蚀。自第四纪（距今260万年）以来，间歇性上升形成了三级古剥蚀面，终于形成了今天的黄山。在这些岩体中，由于在矿物组分，结晶程度、矿物颗粒大小的差别而造成抗风化能力不同，节理的性质、疏密程度和方向的变化，加之丰沛地表流水的侵蚀，最终造成了花岗岩奇峰林立的黄山美景。

在立马桥、天都峰、北海等地段，被认为具有第四纪冰川遗迹。黄山冰川的存在与否，已争论了半个多世纪。这也是黄山地质公园又一诱人的魅力所在。黄山以奇松、怪石、云海三奇和丰富的水景以及它们的相互组合，古往今来，一直为人们赞誉和向往。

张家界世界地质公园：

位于湖南西部，面积3600km^2，以石英砂岩峰林地貌著称。区内泥盆纪厚层石英砂岩，产状近水平，北东向、北西向和南北向三组垂直节理发育，流水冲刷和重力崩塌，雕琢出奇特的景观，暴露时间的长短和节理裂隙发育程度不同，形成石山、石墙、石柱、石峰、石门、天生桥等，鬼斧神工，形态各异。区内共有砂岩峰柱3000余座，伟岸挺拔，蔚为壮观，其中高度超过200m的有1000余座，以金鞭岩最高，达350m。特别可贵的是在峰柱之上多生有松树、银杏等。枝繁叶茂，盘根错节，恰如放大的盆景；沟壑纵横，山青水秀，苍翠欲滴，虬枝盘曲，物种繁多，又是一名副其实的植物园。园内还有一石灰岩溶洞，千奇百怪的石笋，石钟乳也为本区增添了另一类景观。

首批中国八家入选的世界地质公园，从地球科学价值突出，其地质科学研究工作在地质科学史上也都占有重要地位。江西的庐山自古有“匡庐奇秀甲天下山”之说，是闻名天下的避署胜地，又是我国第四纪冰川研究的发祥地，李四光教授的“庐山之冰川”研究工作是具有划时代意义的，所建立的第四纪冰川地层剖面一直被作为中国东部的对比标准，虽然成因上的争论至今仍未结束，但这种学术上的百家争鸣正是推动本区学术研究不断深入和进步的重要动力，庐山地学景观的骄人之处还在于独特的变质核杂岩构造，以及放射状奔流的地表水系及其冲刷作用产生的罕见的地质遗迹；石林声名鹊起于上世纪30年代，最近十余年来，公园领导者敏锐地预感到知识旅游、科学旅游萌动的春潮，果断地从门票收入中，拿出1%支持科学研究。十年终结硕果，在岩溶形成机理的探索、石林地貌的形成过程，我国西南卡斯特的全球对比等方面，有关论文专著不断产出，学术讨论会吸引了大批国内、外一流学者，新理论、新观点逐一涌现，石林已在全球岩溶研究中的地位如日中天；嵩山居五岳之中，少林寺的拳棍在令游客眼花缭乱的同时，也遮住了嵩山地质构造地层剖面的夺目光彩，人们一提嵩山就只想到少林寺，若大嵩山竟与少林寺等同起来，事过景迁本区的宗教旅游已风光不再，嵩山三大构造运动地质遗迹的壮美，五个地质时代地层剖面的完整，深刻的科学底蕴与其厚重的文化积淀一样，招唤一批批莘莘学子，聚集起一批批国内外地学巨匠，来此探索地质构造运动的机理，上世纪60年代温家宝总理就曾师从著名大地构造学家马杏垣先生，为探索嵩山地学奥秘洒下了辛勤的汗水；丹霞山因其峻岭长墙如虹彩飞霞而使冯景兰、陈国达等老先生遐想连篇，以“丹霞”冠之，后人群起引用对比，在我国竟找到600余处相似的地学景观，于是丹霞地貌就成了广为接受的一种地貌类型，自然而然，粤北的丹霞山就成了“祖爷爷”；五大连池对大家都是耳熟能详的名字，在我们的小学课本上已有介绍，作为我国喷发时间最新的休眠火山群之一，其喷发火山熔岩类型齐全，千姿百态，特别是1000

多个喷气叠锥更是举世无双；云台山是我国首批八个世界地质公园的后起之秀，位于八百里太行之阳，在东亚大裂谷控制和影响下，伴生的北东向、北西向和南北向断裂切割元古界石英砂岩、下古生界的灰岩和白云岩，来自太行西北坡的溪流飞泻而下，沿薄弱带冲蚀，刻切出雄奇的峡谷和峰岭，加之地处中原，山川之秀美令人叹为观止；黄山是被徐霞客赞誉为“登黄山天下无山”的绝妙胜景，莲花峰天都峰等七十二峰，飞来石、八戒石等怪石模拟象形惟妙惟肖，黄山青松挺拔伟岸令人肃然，可能因为其景观实在太使人陶醉了，竟忘记了去追索早白垩世四次花岗岩浆侵入活动形成的不同岩石性质，对这些美景形成的控制作用，后期的垂直和水平节理裂隙造就奇形怪石的鬼斧神工，花岗岩中钾长石风化对黄山青松扎根山崖的“默默奉献”美景天成，地质学家更有责任去求索地质、气候条件的得天独厚；张家界是又一处令人怦然心动的奇妙景观，泥盆系的石英砂岩，在静静平卧三亿年后，随地壳的上升形成了三组断裂，丰沛的雨水冲蚀拓展这些断裂形成深谷和断墙，进一步崩塌成数以千计的巍然耸立的岩柱，点缀了无数虬茎盘根的松柏银杏，大自然真就造化出如此美仑美奂的人间仙景，也给我们地学工作者提出了一个又一个的问题，等待我们去作出科学的解答。

中华大地实在是物华天宝，我们首批申报的这批地质公园更是一流的精品，教科文组织原来希望中国报送4~5个候选地，当他们的专家来华考查后无不被我们的地质遗迹资源、科学研究成果和规范的管理所折服，在评审过程中，来过的专家交口称赞，没有来过的专家就更是希望一睹为快，不断表示愿意来华一游，最后全部投了赞成票，一致通过了我国八个申报候选地为首批世界地质公园。

当然，来自五大洲的地学专家也不是泛泛之辈，他们资历很深，都是各分支学科的学术带头人，见多识广，加之有欧洲十七个地质公园的比较，在评审过程中提出了很多问题，这些问题正是世界地质公园网络指南所要求的重要条件，对于我国首批世界地质公园的建设和以后的申报工作很有指导意义。归纳起来有如下几点：

1 加强和深化地学研究工作

要确定申报地的地质遗迹是否记录了地球演化历史的重要历程，是否具有重要地球科学价值，这就需要地质学家的研究工作。英国的地质公园评审中，特别强调地质资料的完整正确，分析测试数据的取得和研究，岩石、矿物和古生物化石的鉴定分析结果等，相比之下，我们的一些地质公园还有不小差距。

2 科学普及工作

我国的八个世界地质公园都已建立了地质博物馆，或者展示陈列室，展出了本区的地质基础工作成果图件，标本和专著及论文等，还有不少国内外相似地质遗迹的对比研究成果，这无疑是大众科学教育的重要基地，但其缺点是科普性不够，太专业化了、不太通俗易懂；再则展示手段单调，声、光、电等现代技术用得不多，影响了科普基地作用的充分发挥。

各公园导游人员地学知识培训还应进一步加强，不少导游人员还不能自如地将地球科学知识融入解说之中，更不用说给外宾用外语介绍本区的地学特征了。

各公园的标示牌、说明牌甚至游路的规划应作修改和调整，补充地质科学内容，新增或调整游路使之更能结合科学系统的解释和知识体系的完整，切实提高旅游的科学知识含量。

科普读物的编写和出版是使地质学家的科研成果从象牙之塔中走向广大民众的途径，也是科

学服务社会经济发展的重要举措，但仅仅靠地质学家不行，必须使善长文学创作的科普作者与地质学家结合起来，才能写出大众喜闻乐见的作品。

学生的实习，民众的参与是地质公园科学普及的重要形式。青年人求知欲强，中小学生有非常强烈的好奇心，总是带着“宇宙是怎么形成的?”“生命是怎么产生的?”“人类智慧是怎么形成的?”这样一些问题走进地质公园，不同的地质公园正可以从不同角度来满足青少年的好奇心，日积月累，我们大众的科学素质的提高就会在寓教于游中完成。

3 充实地质公园的科学家队伍

地质学家、生物学家、环保生态专家都要关心地质公园的建设。

在地质公园（或森林公园等）中管理层和导游队伍都应有一些学习自然科学或地质（森林）工作者参与公园中旅游资源的调查、规划、建设和旅游服务。这是提高我国旅游产品科学水平的途径之一，欧洲地质公园中就有不少地质工作者，他们在推动欧洲的知识旅游方面发挥了重要作用。

以上仅仅提了一下联合国教科文组织地质公园顾问专家组成员们有关地质公园科学性的意见，因篇幅原因未作分析，也未能涉及其他，诸如完善领导机构，动员地方领导和民众的支持，管理制度和法规的完善，策划专项旅游产品，与各种不同品牌的协调（如自然文化遗产），广开当地居民的就业渠道，支持地方经济的可持续发展等等，这里就不再一一赘述。

我国政府提出了科学发展观的概念，地质公园的建立和建设正体现了这一观念，也是落实“三个代表”重要思想的一件实事，这一工作必将为我们伟大祖国的社会主义建设事业作出应有的贡献，为我国经济社会的可持续发展注入新的活力。

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Geoscience - the basis of geopark establishment

Zhao Xun[1], Zhao Ting[2]

1. Chinese Academy of Geological Sciences
2. Institute of Mineral Resources, Chinese Academy of Geological Sciences

On 13th February 2004, in its headquarters in Paris, the United Nations Educational, Scientific and Cultural Organization (UNESCO) held a meeting to designate the first batch of world geoparks. The meeting unanimously approved 28 world geoparks, among which eight are located in China, and 20 in European countries, including the UK, France, Spain, Greece, Ireland, Austria, Italy and Germany.

Pursuant to the decision of its Executive Bureau in June 2001 (161 EX/Decisions, 3.3.1), UNESCO has been invited to support the efforts of Member States to promote territories or natural parks having special geological features. In April 2002, UNESCO'S Division of Earth Sciences officially issued the Operational Guidelines of the UNESCO Network of Geoparks, and began to accept applications from national geoparks seeking UNESCO's assistance. The Operational Guidelines elucidate explicitly the criteria and functions of geoparks, and set demands on conserving the geological heritage, fostering the geological-ecological environment, research on geoscientific significance, popularization of earth sciences, development of knowledge and science tours in order to promote sustainable development of the local economy, creation of employment opportunities for local residents, etc., with emphasis on geoscientific research and popularization.

China application for the inclusion of its eight national geoparks in UNESCO network placed emphasis on the scientific significance of the candidate sites, i.e. the significance of the local geological heritage in the evolution of the earth, and the position of local geoscientific research in the history of the earth sciences. Generally speaking, the scientific significance of China first world geoparks is reflected in two aspects: tracking the sources of special events and processes in the evolution of the geological heritage, and establishing research bases for epoch-breaking academic achievements. These are the basis for assessing the scientific value of world-level geoparks, the criteria for defining world geoparks, and the resources basis for geoparks in the service of society.

The main features of China first world geoparks

Lushan World Geopark

Located in the north of Jiangxi Province, bordering Lake Poyang and facing the Yangtze River, Mount Lushan is geologically of block structures formed by the elevation of a horst, occupying an area of 500 km^2. The lofty mountain, luxuriant vegetation, waterfalls and green pools combine to create charming and pleasant scenery. Pavilions, temples and pagodas are dotted on the mountain, now appearing, now disappearing in the mist. The Quaternary glaciation section established in the 1930's by Professor J.S. Lee (Li Siguang) is still well preserved, and the glacial remnants can be easily

recognized. Furthermore, many important events in the modern and contemporary history of China occurred in this area, and the historical relics add to the fascination of the geopark.

Shilin (Stone forest) World Geopark

Situated in Yunnan Province and covering an area of 400 km2, Shilin Geopark is characterized by carbonate peak forests consisting of Late-Paleozoic neritic facies limestone and dolomite. Vertical joints are well developed in the thick-bedded carbonate rocks, along which plentiful rainwater dissolved downwards and brought about various karst forms, e.g. stone teeth, solution channels, funnels, peak forests, dissolution basins and many others, of which the most magnificent is the erosion peak forest. The myriad peaks, ranging from 20 m to 50 m in height, resemble a variety of things such as pillars, swords, pagodas, mushrooms, human beings, animals and whatever else one can imagine. They shot up and formed a dense mass of stone trees; hence they bear the name "Stone Forest." This area also features the local customs of the Yi minority. Rock paintings in Yi style and inscriptions on precipices in the Yi language are found in many places hereabouts.

Songshan World Geopark

Located in northwestern Henan Province and covering an area of 450 km^2, Mount Songshan is known as " a textbook of earth history" by virtue of the completely exposed stratigraphic sections and the geological heritage of angular unconformity of three Precambrian tectonic movements. It boasts outcrops from 3500 Ma B.P. to the present, embracing the Archean, Proterozoic, Paleozoic, Mesozoic and Cenozoic eras, and is the naming place of such tectonic movements as Songyang (2300 Ma), Zhongyue (1850 Ma) and Shaolin (570 Ma). The bedding planes of the angular unconformity and the overlying basal conglomerates are clearly discernible. Songshan is one of the birthplaces of ancient Chinese culture, having numerous historical relics, including temples, pagodas, an academy of classical learning, etc. With its geological heritage contrasting finely with its cultural relics, the area has now become a tourism hot spot.

Danxiashan World Geopark

This geopark is located in Shaoguan, Guangdong Province, and covers an area of 290 km^2. Landforms characterized by cliffs and rock walls consisting of red continental sandy conglomerates are called the Danxia landscape, and Danxiashan is the naming place of it.

Danxiashan is situated in an intermountain basin of overall red-bed peak forest structure, with over 380 peaks, stone fortresses, walls and pillars, big and small. The highest peak, Bazhai, is 618 m a.s.l., while most of the peaks are 300-400 m a.s.l. Varied in height and shape, the multitude of peaks forms a most spectacular scene. Mount Danxia is composed of Cretaceous red sandy conglomerates. The Danxia landscape with peaks of different shapes and combinations resembles a thousand-year-old stone fortress. The standing stones look like sculptures of human beings, animals, birds, etc., only they are not masterpieces made by any craftsman, but by Nature.

The rocks constituting the Danxia landscape are red fluvial-lacustrine sandy conglomerates of the Late Cretaceous, dated 70 to 90 Ma. About 65 Ma ago, as a result of tectonic movements, many faults and joints were produced in this area, and the whole Danxia basin was subject to denudation. The Himalayan movement of 23 Ma B.P. caused the rapid elevation of the area. Eons of intermittent rising and weathering have made the area extremely beautiful and spectacular.

Wudalianchi World Geopark

Located within the boundaries of Wudalianchi City in Heilongjiang Province and covering an area of 720 km^2, this geopark features a well-preserved group of 14 volcanoes, of which 12 erupted 12 to 1 Ma ago, and two in the years 1721 and 1791, respectively. The cones are intact. The lava flow gushing from the craters extends over 10 km, which dammed the river and produced five beaded lakes. Fumaroles, exhalation cones, lava tunnels, volcanic bombs, lava terraces, ropy lava, and other features are well preserved. The local therapeutic mineral springs attract visitors from Russia, Japan, South Korea and other countries, as well as other parts of China.

Yuntaishan World Geopark

Located at the southern foot of Taihang Mountains, along the Jiaozuo and Xiuwu Cities, this geopark neighbors the western boundary fault of the Cenozoic East-Asian rift system of the North China landmass. Records of the earth' s evolution for 2,500 Ma are well preserved. In particular, the epicontinental sea sediments of quartzose sandstone, argillite and carbonatite of the Mid-Proterozoic to Early Paleozoic periods, and the paralic and continental sediments of the Carboniferous and Permian periods are characterized by well-developed successions, varied facies, and rich fossils. Dissected by three groups of differently oriented faults and joints, and scoured and eroded by plentiful surface water, the horizontal beds have been molded into stairstep walls, wall-like ridges with grotesque rocks, deep urn-shaped ravines and long gorges. The landforms are peculiar and secluded, with waterfalls, hanging springs, thick vegetation and unique biodiversity.

Huangshan World Geopark

Situated in the mountainous area of southern Anhui Province and covering an area of 500 km^2, Mount Huangshan features granite peak forest landscape, being best known for numerous imposing peaks, of which 72 exceed an altitude of 1,000 m. The excellence of the scenery with a combination of fantastic peaks, tall and straight green pines, grotesquely shaped rocks, sea of clouds, and hot springs has been highly praised by visitors.

In the Late Jurassic, about 140 Ma ago, high-temperature magma intruded upwards along fractures at places where the crust was comparatively thin and weak, forming mutual-intersecting granite bodies in four phases. Around 650 Ma ago, the Huangshan granite body was strongly uplifted. Crustal elevation and functions of compressional stress from different directions generated joints of varied orientation. The intrusive bodies and the cover rocks underwent weathering and erosion. From the Quaternary (2.6 Ma

ago), intermittent uplifting created a three-level ancient denudation plane that eventually formed Mount Huangshan. As a result of the difference in mineral composition, crystallization degree and grain size, the resistance to weathering and the character, density and orientation of the joints of the rock bodies are different, which, in company with the erosion by plentiful surface water, has brought about the beautiful landscape of the granite peak forest of Huangshan.

Quaternary glaciers are considered to have occurred at the sites of Limaqiao, Tiandufeng, Beihai, etc. The existence of Huangshan glaciation has been under debate for over half a century, which has become another attraction of the Huangshan Geopark.

Zhangjiajie World Geopark

Located in the west of Hunan Province and covering an area of 3,600 km2, this geopark is famous for quartzite sandstone peak forests. Thick-bedded quartzite sandstones of the Devonian Period occur in the area, and three groups of NE-, NW- and NS-striking vertical joints are well developed. Hydraulic scouring and gravity collapse have carved out spectacular scenery. Due to different durations of exposure and development of joint fractures, rocks assuming various shapes like stone hills, stone walls, stone pillars, stone peaks, stone doors, natural bridges, etc. have been produced. The geopark features over 3,000 sandstone pillars, with over 1,000 exceeding an altitude of 200 a.s.l., the highest Jinbian Rock being 350 a.s.l. Particularly notable are the pines and ginkgoes that cover the tops of the pillars, resembling a natural potted landscape. Because of the great diversity of plants, the geopark is a virtual botanical garden. In the geopark there is a karst cave with impressive stalactites and stalagmites.

Geoscientific value of China eight world geoparks

The eight world geoparks in China boast prominent geoscientific value, and research into them takes an important position in the history of earth sciences in China.

Mount Lushan, in Jiangxi Province, has been a famous summer resort since ancient times, and is also the birthplace of Quaternary glaciation in China. Research by Professor J.S. Lee (Li Siguang) on the Lushan glacial deposits are of epoch-making significance. The stratigraphic cross-section of Quaternary glaciation he established has been taken as the correlation criteria in eastern China. Although debates on its origin continue, the contentions of different schools of thought have become a driving force for in-depth academic study and advancement of the area. The attractions of Lushan include also the unique metamorphic core complex structures and the geological heritage generated by the scouring of the radiated river system.

Shilin has been world famous since the 1930s. During the past decade, the park authorities, foreseeing an upsurge in knowledge and science tours, allocated 1% of the income from admission fees for scientific research. As a result, remarkable achievements have been made in research into the formation mechanism of karst, the formation processes of the topography of Shilin, and the global correlation of karst in southwestern China. On these subjects, many articles and monographs have been published, symposia have been held with the presence of many top geoscientists from both at home and

abroad, and new theories and concepts have emerged. Shilin is now in the forefront of global karst studies. Songshan Mountain is situated in the middle of the Five Mountains of China (Taishan in Shandong, Hengshan in Hunan, Huashan in Shaanxi, Hengshan in Shanxi and Songshan in Henan). At one time, people only associated Songshan with the Shaolin Monastery and its martial arts. But nowadays the geological heritage of the three tectonic movements and the completeness of the stratigraphic sections of the five geological periods at the Songshan Mountain fascinate numerous leading geoscientists who are interested in the mechanism of geotectonic movements. In the early 1960s, Premier Wen Jiabao, then a student of Professor Ma Xingyuan, did research work here.

Danxia Mountain is located in northern Guangdong Province. It was named Danxia (rosy clouds) by two veteran Chinese geologists, Feng Jinglan and Chen Guoda, because of its high red ranges and long walls. Since then, over 40 such landforms have been found throughout the country, and the Danxia landscape has become a widely accepted topographic type in China. Mount Danxia in northern Guangdong is naturally regarded as "grandfather" of its kind.

Wudalianchi should be a very familiar name to many people, as it is mentioned in primary school textbooks. Being one of China lately erupted dormant volcano groups, it has eruptive lavas in thousands of postures. The more than 1,000 cone-in-cone structures, in particular, are unmatched in the world.

Yuntai Mountain is situated south of the Taihang Mountains, under the control and influence of the East-Asian rift valley system. The accompanying NE- and NW-striking faults dissect the Proterozoic quartzose sandstone and the Lower Paleozoic limestone and dolomite. Streams flowing from the northwestern slopes of the Taihang Mountains flowed over the Yuntai Mountain, and scoured along fractures and joints, giving shape to ravines and peaks.

Mount Huangshan was praised as an extremely beautiful scenic spot by Xu Xiake (1585-1641), a traveler, geographer and writer of the late Ming Dynasty. A famous saying of his goes: " After reaching the top of Mount Huangshan, one will find no other mountain in the world." The mountain's 72 peaks, including Lianhua and Tiandu, and grotesquely-shaped rocks such as Feilaishi (erratic stone) and Bajieshi (pig-headed monk-like stone) are most attractive. The solemn, tall pine trees arouse the admiration of tourists, and add greatly to the beauty of Huangshan. The area is noted for the controlling functions of different rock properties over the landforms produced successively in the four intrusions of granitic magmas during the Early Cretaceous period, the wonderful craftsmanship of the vertical and horizontal joints and fractures which created the grotesque rocks, and the contribution of the weathering of K-feldspar in granites to the growth of the pines in the cliffs. It is the responsibility of geologists to explore the unique geological and climatic conditions of the workings of Nature in Huangshan.

Zhangjiajie is another noted scenic spot. After lying horizontally for three hundred million years, the quartzose sandstones of the Devonian Period formed three groups of faults during crustal elevation. Plentiful rainwater scoured and expanded the faults, producing deep ravines and broken walls, which collapsed and formed thousands of majestically standing pillars decorated with numerous twisted roots and gnarled branches of pine, cypress and gingko.

This wonderful scenery has also put forward questions another awaiting explanations by geologists.

Comments on the eight geoparks

China enjoys a particularly rich natural endowment. The eight national geoparks we proposed are among the best in China. UNESCO had hoped that China would propose four to five candidate sites. However, after making in-situ investigations, the members of the UNESCO International Advisory Group were impressed by the geoheritage resources, the geoscientific findings and the standardized administration of these geoparks. At the designation meeting, the advisors who had joined the excursions spoke highly of the sites, and those who had not paid the visits expressed their desire to see the scenery with their own eyes. After discussions, all the advisors voted in favor of the eight candidate sites, which were thus unanimously approved for inclusion among the first World Geoparks.

The members of the International Advisory Group have a long list of credentials in their chosen earth-science discipline or sub-discipline. Compared with the approved European world geoparks, and based upon the criteria stated in the Operational Guidelines of the UNESCO Network of Geoparks, they made many comments on the eight Chinese geoparks at the meeting, which were instructive for the further construction of the geoparks and for our proposals for candidate sites in the future. The comments can be summarized as follows:

1. Enhancing and deepening geoscientific research work

To judge if the proposed geological heritages have recorded the important processes of the evolutionary history of the Earth, and if they are of significant geoscientific value, research work by geoscientists is indispensable. The British geoparks have paid particular attention to the completeness and accuracy of geological materials, the acquisition and study of analytical and testing data, the results of the identification of rocks, minerals and fossils, etc. In contrast, some of the Chinese geoparks still have a long way to go.

2. Promoting scientific popularization

China eight world geoparks have all established a geological museum or exhibition hall, with maps showing achievements made in local basic geological work, and specimens, monographs and articles, as well as correlations with similar geological heritage sites at home and abroad. They are very important for public scientific education. But the exhibits are unfortunately too professional and not in popular and easy-to-understand language. Moreover, the displays are monotonous, with rare use of sonic, optical or electronic media.

The geoscientific training of tour guides should be improved. Many guides are incapable of incorporating geoscientific knowledge in their explanations, not to mention the ability to introduce the geological features to foreign visitors in a foreign language.

Signs, explanation boards and even the planning of tourism routes in the geoparks should be modified and adjusted to match the geoscientific content. Tourism routes should be increased or adjusted, and the scientific content of tourism in the parks should be substantially upgraded.

The compilation and publication of popular science readings is an appropriate avenue leading