

新元古代地质遗迹资源研究

——安徽灵璧磬云山地质遗迹资源 评价与保护

◎ 桂和荣 朱洪 马艳平 费玲玲 等 著



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——安徽灵璧磬云山地质遗迹资源评价与保护

Research on geological relics of Neoproterozoic Era

——Assessment and protection of geological relics in Qingyun Mountain, Lingbi, Anhui

桂和荣 朱 洪 马艳平 费玲玲 等 著



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内 容 简 介

本书全面分析了地质遗迹资源的内涵与价值、地质公园的分类及其在保护地质遗迹资源中的重要作用,介绍了国家和安徽省地质公园的建设现状、灵璧石文化的发展历程。深入研究了区域新元古代地质背景及安徽灵璧磬云山地区地质特征,阐述了磬云山国家地质公园典型地质遗迹的成因机理及其地球科学意义,同时开展了国内外对比研究。在此基础上,建立了地质遗迹资源评价模型和评价指标体系,实施了磬云山地质遗迹资源评价。从地学研究、科普、公园信息化建设、地学旅游发展与推广等方面,论述了地质遗迹资源保护和地质公园可持续发展的举措。

本书可供地质公园、地质遗迹、资源环境、发展规划等管理人员阅读,也可供地质学及相关专业的教学、科研及工程技术人员参考。

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前 言

地质遗迹是在漫长的地质历史时期由内、外力地质作用形成的，它反映了地质历史演化过程和物理、化学条件及环境的变化。地质遗迹是不可再生的，一旦遭到破坏就永远不可恢复，也就失去了研究地质作用过程和形成原因的实际价值。因而，保护和利用好地质遗迹，对于人类认识地质现象、推测地质演化及恢复地质历史等具有重要意义。

在地质作用留下的形形色色地质遗迹中，有的地质遗迹比较独特，除了可供地质学家“将今论古”，进行地学研究外，还有可供人类开发利用的经济、社会和文化价值。因而，地质遗迹也是一种资源，而且是稀缺资源。我国地域辽阔，地理条件复杂，地质构造形式多样，地质遗迹资源丰富，在世界上享有盛名。

为了保护和利用地质遗迹资源，建立地质公园是一项有效的举措。地质公园以其特殊的地质科学意义、稀有的自然属性、较高的美学观赏价值，越来越受到人们的追捧。地质公园既为人们提供具有较高科学品位的观光旅游、度假休闲、保健疗养、文化娱乐的场所，又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。可见，地质遗迹资源的典型性、稀缺性和观赏性决定了地质公园的品位。

安徽东北部宿州灵璧地区发育了一套较完整的新元古代碳酸盐岩地层，在8亿~10亿年的地质演变过程中，留下了许多珍贵的地质遗迹，一直受到国内外地质学家的关注。特别在研究前寒武纪地球动力学、矿物岩石学、古生物地史学等方面，灵璧地区无疑是一块难得的宝地。灵璧石是灵璧地区众多地质遗迹的一种，位居我国四大奇石之首，被乾隆帝御封为“天下第一石”，长期以来，灵璧成为赏石文化繁荣的热土，闻名海内外。

2008年，宿州市人民政府委托宿州学院专家学者启动了“灵璧石资源调查与评价”项目研究，在深入分析区域地层、构造条件的基础上，对灵璧境内新元古代地质遗迹进行了摸底，探讨了各种地质遗迹的成因机理，提出了包括灵璧石在内的地质遗迹资源保护和开发利用的具体措施。从此以后，申报和建设安徽灵璧磬云山省级和国家地质公园工作陆续展开，并取得了初步成效。

本书在总结灵璧新元古代地球科学研究成果的基础上，结合省级和国家地质公园建设的经历，对安徽灵璧磬云山地质遗迹资源进行了系统研究，所取得的成果和认识体现在以下六个方面。

(1) 基于地质属性、遗产属性和资源属性,阐述了地质遗迹资源的内涵及其构成要素;分析了地质遗迹资源的资源、科研、审美和生态环境价值。从保护和利用地质遗迹资源的角度出发,对地质公园的作用、类型以及安徽省内外地质公园建设现状进行了剖析,为灵璧磬云山地质遗迹资源保护和利用、地质公园建设与发展奠定了基础。

(2) 在区域地质及地形地貌分析研究的基础上,确定磬云山作为地质公园的主园区。该园区地貌形态属低山丘陵,地貌成因属侵蚀-溶蚀地貌,基岩裸露范围大,有利于地质遗迹观察;坡麓、坡台地带被第四系松散层覆盖,埋藏了千奇百怪的灵璧石。灵璧石拥有 3000 多年的开采和观赏历史,自古便受到帝王将相、文人雅士的青睐,灵璧石文化源远流长。

(3) 磬云山所在的皖北地区大地构造位置属华北板块的东南缘。据区域地质调查与填图,发现本区曾发生过以印支—燕山早期为主的多次地壳运动。区域内发育的地层主要为上元古界震旦系、中生界侏罗系及白垩系、新生界古近系及第四系,古生界地层在本区缺失。其中上元古界震旦系发育贾园组、赵圩组等岩石地层单元,并且具有各自的岩石、矿物和地球化学特征。

(4) 依据地质遗迹资源调查成果,按照国家关于地质遗迹划分标准,将磬云山地质遗迹划分为地质剖面、地质构造等六大类,类型齐全。通过成因研究以及与国内外新元古代地层对比分析,可以看出,磬云山灵璧石、白齿构造等地质遗迹十分珍贵,对于研究新元古代内外地质作用、恢复前寒武纪地质历史具有重要的科学意义,同时具有很高的观赏价值。

(5) 以国家地质公园建设标准为基础,构建了磬云山地质遗迹资源的评价指标体系和基于 AHP 法的评价模型。根据评价指标模糊级别值,采用德尔菲法进行评价,通过专家打分来获取各地质遗迹评价值,并对各分值进行处理;再利用改进的罗森伯格-菲什拜因公式,计算地质遗迹资源综合评价值,进而从地质遗迹资源类型和地质遗迹景点两方面进行评价,为磬云山地质遗迹资源有效保护、地质公园科学规划与建设提供了科学依据。

(6) 通过区域地质调查和地质遗迹资源评价,充分利用山脊线、山谷线、陡崖边坡、道路、土地权属边界等具有明显分界特征的地物界限,合理划定了磬云山国家地质公园的范围,设定了公园边界地理坐标;合理划分了公园功能区和地质遗迹保护区,并计算了公园的环境容量;制定了人才培养与培训、科研选题与科普、公园信息化建设等规划;开展了磬云山国家地质公园旅游市场调查,对游客行为、消费偏好等调查结果进行分析,为磬云山旅游资源的科学开发提供了参考。

本书内容共六章。第一章由朱洪、桂和荣、刘磊执笔;第二章由桂和荣、朱洪、贺振宇、刘磊执笔;第三章由桂和荣、马艳平、张承云、刘杨执笔;第四章由桂和荣、孙林华、陈松、贺振宇、王跃、费玲玲执笔;第五章由朱洪、费玲玲、

桂和荣、张承云执笔；第六章由朱洪、费玲玲、桂和荣、王永、杨强执笔；前言由桂和荣执笔。全书由桂和荣、朱洪统稿，英文翻译由桂莅鑫负责。

限于作者水平和条件，书中一定会存在不足，引述前人的研究成果、资料和论点抑或有疏漏，在此恳请读者批评指正。

著 者

2017年11月

Foreword

Geological relics are the remnants from the long geological periods. Developed under internal and external geological forces, the relics bear evidence to the geological movements and changes in physical and chemical conditions. Geological relics cannot be replicated or regenerated. Once damaged, it would be impossible to restore them to original forms and lose the values in the relics to scientific research. Therefore, geological relics must be well protected and utilized for the benefits of human beings to understand geological phenomena, simulate geological evolution, and uncover geological history.

In the kaleidoscope of relics left behind by geological processes, some are so unique and useful for geological studies while some others are of economic, social, and cultural values. It is fair to say that geological structures are rare resources. Across China's vast land, complex geological conditions gave birth to various forms of geological structure. China's abundance in geological relics is well-known globally.

In order to protect and utilize geological heritage, building geoparks is an effective measure. Geopark is becoming more and more popular with people for its scientific significance, rarity, and aesthetic value. Geoparks are tourist destinations and resort for leisure and entertainment, as well as reservation of geological for geological scientific research. Evidently, the rarity and aesthetics of geological relics set the tone for the geoparks.

Lingbi in the northeast of Anhui Province is home to a relatively complete set of Neoproterozoic carbonate rock strata. 800 million to 1 billion years of the geological evolution left countless precious geological relics that have global interests, especially in the study of the Precambrian geodynamics, mineral petrology, paleo-biological history, etc. Lingbi area is undoubtedly a rare treasure house. Lingbi Rock is a kind of geological relics in the Lingbi area. It ranks first in China's four rare rocks and was crowned by the Qianlong Emperor as "the first stone in the world." For a long time, Lingbi has become a hot spot for stone culture both at home and abroad.

In 2008, the Suzhou Municipal People's Government invited experts and scholars from Suzhou University to start a research project to evaluate Lingbi Rock resources.

Based on an in-depth analysis of regional stratigraphic and geological conditions, the project explored the Neoproterozoic geological remains in Lingbi, discussed the formation mechanism of various geological relics, and put forward concrete measures for the protection and utilization of geological relics including the Lingbi Rock. Later, application to make Qingyun Mountain a provincial and national geopark was started and made preliminary success.

By summarizing the achievements of the research on Neoproterozoic geological environment in Lingbi, this book presents the experiences in building provincial and national geopark and systematically studies the geological heritage in Qingyun Mountain, Lingbi of Anhui. Main achievements and understanding is reflected in the following six aspects.

(1) Define geological relics as geological formations, heritage, and resource; analyse the value of geological relics as resources, scientific effects, aesthetic artefacts, and to ecological environment. From perspectives of protecting and utilizing geological relics, the article looks into the roles of geoparks and the other geoparks in and outside Anhui province, offering support to the protection and utilization of geological relics in Lingbi and the establishment of a geopark in Qingyun Mountain.

(2) Based on the analysis of regional geological and landforms, Qingyun Mountain is chosen as the main site for the proposed geopark. The park is featured by low mountains and hills formed by erosion and dissolution. The base rocks are widely exposed, convenient for observation. Foothlope and slopetop are covered by Quaternary loose bed, burying underneath Lingbi Rock of thousands of forms. Mining and appreciation of Lingbi Rock can trace back to 3,000 years ago, widely treasured by royal families and literati.

(3) Qingyun Mountain is located in north Anhui province. Its geotecture sits on the southeast edge of Huabei plate. According to geological investigation and mapping, this area underwent multiple tectonic movement, primarily on early Indosinian-Yanshan line. Strata in this area are predominantly Sinian of upper Proterozoic, Jurassic and Cretaceous of Mesozoic Erathem, and Paleogene and Quaternary of Cenozoic Erathem, missing Paleozoic strata. In Sinian strata of upper Proterozoic, there are Jiayuan Group, Zhaowei Group, and other rock units, showing individual lithological, mineral, and geochemical attributes.

(4) With the investigative results, geological relics in Qingyun Mountain are divided into six categories in accordance with national standards. Genesis studies and comparison of Neoproterozoic strata home and abroad show that Lingbi Rock and

molar-tooth structure from Qingyun Mountain are highly precious, both from scientific and aesthetic perspectives. Scientifically, the relics offer insights into the geological processes in Neoproterozoic Era and reconstruct geological events in Precambrian period.

(5) Based on the national geopark standards, assessment criteria based on AHP model are established to evaluate geological relics in Qingyun Mountain. Delphi method is applied and invited a panel of experts to assess the values of the geological relics. The grades are processed accounting for the fuzziness of each criterion. Overall assessment results are obtained by inputting the grades into the extended Fishbein-Rosenberg model. The assessment, which clarifies the type of geological resources and value as tourist sites, produces comprehensive evaluation of the geological heritage in Qingyun Mountain. The results are of reference for geopark planning and construction.

(6) Through investigation and assessment of regional geological relics, surface features are demarcated by ridge line, valley line, steep slope, roads, land rights and other distinct boundaries to delineate the geopark area. Geographic coordinates are set accordingly. Function areas of the geopark are properly separated from conservation areas, accounting for the park's capacity. Plans for staff training, scientific studies, IT infrastructure and others are set out holistically. Market research focusing on the tourism potentials of the geopark has been conducted to understand consumer behaviour and preferences, laying the foundation for future development of tourism resources in Qingyun Mountain.

This book has six chapters. Chapter I is written by Zhu Hong, Gui Herong, and Liu Lei. Chapter II by Gui Herong, Zhu Hong, He Zhenyu, and Liu Lei. Chapter III by Gui Herong, Ma Yanping, Zhang Chengyun, and Liu Yang. Chapter IV by Gui Herong, Sun Linhua, Chen Song, He Zhenyu, Wang Yue, and Fei Lingling. Chapter V by Zhu Hong, Fei Lingling, Gui Herong, and Zhang Chengyun. Chapter VI by Zhu Hong, Fei Lingling, Gui Herong, Wang Yong, and Yang Qiang. Foreword is written by Gui Herong. The book is compiled and edited by Gui Herong and Zhu Hong. English translation by Gui Lixin.

Due to capacity and resource constraints, the book is inevitably subject to insufficient reference, literature review, or arguments. The authors appreciate comments from the readers.

Authors

November, 2017

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