

黄金矿山

Gold Mining

地质学

Geology

张宝仁 寸珪 编著

Zhang Baoren Cun Gui

中国建材工业出版社
China Building Materials Industry Press

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内 容 简 介

随着我国黄金工业的迅猛发展,黄金矿山地质已成为黄金矿山开发必不可少的组成部分。本书作者总结多年来从事矿山地质工作,尤其是从事黄金矿山找矿、勘探、设计、基建、生产、管理、科研、教学等方面的实践经验,引证和参考了我国黄金矿山(矿床)的大量地质资料,分四篇共十四章较全面、系统地论述了黄金矿山地质的范畴、理论、方法、内容及其对矿山合理开发和提高矿床学理论水平的作用。书中除了将矿山地质着眼于矿山生产过程地质工作的传统认识外,还将矿山建设前期可行性研究阶段的地质工作、矿山设计阶段的地质工作、矿山基建阶段的地质工作,以及矿山闭坑总结中的地质工作等也包括于矿山地质学的范畴,拓宽了矿山地质学的领域,建立了完整的矿山地质学术思想体系。并将一般性的矿山地质工作与专门性地质工作(如矿山水文地质、环境地质等)紧密地结合在一起,使该书增添了新意。书中还列举了我国 21 个黄金矿山实例,介绍它们的矿山地质、矿床地质、开采方法、选冶工艺、生产与技术经济指标等,并附有黄金矿山地质与测量工作条例等,是一部具有较高学术价值和实用价值的专著。

本书完稿后在沈阳黄金学院矿山地质专业、矿产地质勘查专业讲授三轮,收到了很好的效果。本书可作为高等院校矿山地质专业、地质勘查专业教学用书,也可作为从事金矿地质勘查、矿山设计和科研的技术人员参考用书,及黄金矿山地质人员和管理人员的工具书。

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前 言

随着我国黄金工业的发展,黄金矿山也得到了迅猛的发展,近二三十年来大小黄金矿山相继在全国各地建立起来。随着黄金矿山现代化建设,黄金矿山地质工作也取得了显著成绩。矿山地质已成为黄金矿山开发必不可少的组成部分。矿山地质的概念、任务、范围和作用,以及它的重要性,越来越广泛、深入地地为地质界、矿业界的人士所认识。

本书是作者三十余年从事黄金矿山地质找矿、勘探、评价、生产、管理、设计、科研、教学等实践经验的总结。旨在根据黄金矿业开发的需要,为黄金矿山生产服务,提高黄金矿山地质工作水准,促进矿山地质的发展。本书阐明了矿产资源开发程序,论述了矿山地质学的概念、意义;叙述了岩金矿山各阶段的矿山地质工作任务、内容和方法,岩金矿山开展的专门性地质工作,岩金矿山地质勘探、评价和成矿预测,岩金矿山地质经济问题和矿山开发中一些重要技术工作方法。并对砂金矿山地质作了简要介绍。书中还附录我国 21 个典型岩金矿山实例(每个实例包括矿床地质、矿山地质、矿山开采方式、选矿工艺和矿山生产及主要技术经济指标)。全书共四篇十四章,由编著者分工撰写后张宝仁统编成稿、寸珪审阅完稿,书中英文由袁海军翻译。

本书的编写工作得以顺利完成,得到了编著者所在单位的领导和同志们的大力支持和帮助;冶金部黄金局崔德文副局长,地矿办张泽钦、韩冰、宋玉国高级工程师为本书初稿提出了十分有益的建议;沈阳黄金学院及地质系领导大力支持;学生张云峰、兰启堂、鲍明学、姜文峰、陈刚、王起春、刘峰、张冬、衡振平和地本 4 班、5 班、矿地 10 班、11 班的同学帮助誊稿及描图;武警 10 支队杨秀庆先生、山东省蚕庄金矿邵生南矿长、界河金矿贾玉辉矿长以及河西金矿邵仕琪矿长等资助本书的出版,在此一并表示衷心的感谢。

本书在编写过程中,引证和参考了国内外有关专著、文献及我国黄金矿山(矿床)的大量地质资料;但未正式出版的参考资料,在书中均未列入,恳请谅解。谨向与本书资料来源有关的单位和参考文献的编著者,致以诚挚的谢意。

本书几经修改,已在沈阳黄金学院讲授三轮,收到很好的效果。承蒙中国建材工业出版社赵从旭编审的鼎力支持和帮助;中国科学院院士、地学部主任、著名地质学家涂光炽教授在百忙中特为本书作序,谨一并表示敬意和谢忱。

由于编著者水平有限,书中错误、疏漏在所难免,敬请广大读者批评指正。

著 者

1997 年 1 月

FOREWORD

Gold mines have made rapid progress with the development of gold mining industry in China. Large- and small-scale gold mines were set up in succession throughout the country for the last 20 to 30 years. Owing to modernization of gold mines, outstanding achievements have been obtained in gold mining geology which is a necessary constituent part of gold exploitation. The concept, task, scope, role and importance of mining geology have been realized more and more extensively and thoroughly by people in geological and mining circles.

This book sums up the authors' experience of over than 30 years in geologic prospecting, evaluation, production and management and design, research and teaching related to gold mining, aiming at serving gold production and enhancing the level of gold mining geologic work as well as promoting the development of mining geology. It involves the procedures of mineral resources exploitation, the concept and significance of mining geology, the tasks, scopes and methods of mining geology at each stage of gold mining, the specific geological work for hard rock gold mines, geological prospecting, evaluation and metallogenic prognosis related to hard rock gold mines, hard rock gold mining geological economy, some techniques and methods during mining development and a brief introduction to placer gold mining geology as well, with examples of 21 hard rock gold mines in China, each of which contains geology of ore deposits, mining geology, stoping methods, metallurgy, operation and some main technical and economic indexes of the gold mines. This book consists of 4 parts and 14 chapters which were completed by the authors individually and assembled by Mr. Zhang Baoren. Ms. Cun Gui reviewed manuscripts. The English translation is made by Mr. Yuan Haijun.

The great support and help made by the leaders and colleagues of the authors' units contributes to the smooth completion of the compiling work. Mr. Cui Dewen, Deputy Director of Gold Bureau, MMI, Mr. Zhang Zeqing, Han Bin, and Mr. Song Yuguo, senior geologists of Gold Bureau put forward valuable suggestions on the original manuscript. Zhang Yunfeng, Lan Qitang, Bao Mingxue, Jiang Wefeng, Chen Gan, Wang Qichun Liu Feng, Zhang Dong and Heng Zhenping, the students of Department of Geology and Department of Metallurgy, Shenyang Institute of Gold, as well as students in Mining Geology Classes #4, #5, #10, #11 helped to transcribe the manuscript and drafted the maps and drawings. Mr. Yang Xiuqing, Mr. Shao Shengnan, Mr. Jia Yuhui, as well as Mr. Shao Shiqi, provided financial aid to the publication of this book. We would like to bring our whole-hearted thanks to all units and persons above-mentioned.

Relevant papers and literatures both at home and abroad, and a lot of geological infor-

mation on gold mines or deposits in China as well, were cited and referred to during compilation. We wish to thank the units and authors that supplied us with the related references.

Having been revised for several times, this book had been lectured in the Shenyang Institute of Gold for three times, and the effect was significant. The authors would like to express our sincere gratitude to Mr. Zhao Congxu, copy editor of China Building Materials Industry Press, who offered his assistance and help to this book, and Mr. Tu Guangcun, academician of the Academy of Sciences, China, and Director of Department of Geosciences, the Famous geologist, who wrote the preface for this book.

Comments on this book are warmly welcome.

The Compilers

Jan. 1997

序 言

《黄金矿地质学》一书问世了,这无论对金矿地质界、矿地质界和开采加工部门都是一件好事。

本书作者从事矿地质工作已达 30 余年,对矿地质有着理所当然的深刻的认识与体会。这首先表现在,经过长期实践,作者拓宽了矿地质的领域与思路,即除了将矿地质着眼于矿山生产过程地质工作的传统认识外,将矿山建设前期可行性研究阶段的地质工作、矿山开采设计中的地质工作、矿山基建阶段的地质工作,以及矿山闭坑总结中的地质工作等也囊括于矿地质学的领域内。应当说,上述不同阶段的地质工作都与传统的、经典的矿地质息息相关,它们共同形成密切有机联系的整体。

矿床的勘探报告无疑十分重要,它是进行矿山建设及开发的必需基础资料。但也必需承认,勘探报告立足于较多的“一孔之见”,不可能对矿床求得较全面而又深刻的认识。矿山的设计开采生产过程为对矿床的深化理解提供了可能和条件。因此,提高地质工作的精度,进行尽可能的储量升级,并进而指导开采生产工作便是矿地质人员的光荣职责。为此,在勘探报告的基础上,矿地质工作者还必需进行大量工作,对各种控矿构造、矿石组成、开采条件、技术经济评价等进行细致的观察、剖析、综合。这不仅是矿山合理开发所必需的,而且也对矿床学理论水平的提高有促进作用。正因为矿地质对生产与理论的双重重要性,在 1994 年 9 月由加拿大地质学会主持,召开了专门的世界级或超大型矿床勘查及矿地质讨论会。

本书的另一特点,是除了矿地质理论与方法外,还以很大篇幅阐述了矿地质管理工作。由于作者有多年的地质管理经验,管理与地质的结合便显得很自然、合理、协调。

书中的另一重要特点,是一般性的矿地质工作与专门性地质工作的结合,后者包括诸如矿山水文地质、矿山环境地质、矿地质经济等。如果缺少这些专门性研究,矿地质便是不完备的,难于完成赋予它的任务。在这方面作者的亲身实践与体会为本书增加了份量。

本书还列举了我国 21 个岩金矿山实例,介绍了它们的地质、开采方式、选冶工艺、生产与技术经济指标等。这就使得本书的内容更为完整与齐备了。

相信本书的出版将为从事、参与及关心固体矿产矿地质的同志提供一份有新意的参考材料。

涂光炽

1997 年 1 月

PREFACE

The publication of *Gold Mining Geology* would be beneficial to personnels engaged either in the field of gold mining geology, or in the field of mining and processing.

The authors have profound understanding of mining geology owing to their more than 30 years' experiences in this field. This is mainly proved by the fact that they have broadened the scope and knowledge of mining geology through their long-term work. In addition to the conventional geological work at the mining production stage, the geological work at such periodical stages as the feasibility study in pre-construction stage, the mining design stage, the capital construction stage and mine closing stage is combined in the scope of mining geology. The above-mentioned geological work at different stages is closely related to conventional mining geology, both of which jointly make up an integrated unity.

The deposit exploration reports are undoubtedly very important, as the data in the reports are fundamental and necessary for mine construction and development. However, it is admitted that the data obtained in the reports are based only on the results of a limited number of boreholes and one hardly obtains comprehensive and profound knowledge of mine deposit from these reports. The process of mine design, mining, and production makes one possible to have a deep understanding of deposits. Therefore, improving the precision of geological work, upgrading the reserves and then giving guidance for mining work are the mining geologists' glorious duty. For this reason, mining geologists should carry out a lot of work to observe, analyse and summarize various ore-control structures, ore composition, mining conditions and mine economics on the basis of exploration report which is not only essential for rational mining development, but also enhances the level of geology of ore deposits. Because of the importance of mining geology in both mining production and theory, the Symposium on Prospecting and Mining Geology for World Scale or Super-large Sized Deposits was sponsored by the Canadian Geological Society in September, 1994.

Another feature of this book lies in that mining geological management is discussed in large parts in addition to mining geological theories and methods. The authors combine the management with geology in a natural, rational and harmonic way as a result of their many years' experiences in geological management.

The authors also combine the ordinary mining geological work with professional geological work in the book. The latter comprises mining hydrogeology, mining environmental geology, mining geological economics, etc. Without these professional researches, mining geology would be imperfect and also impossible to fulfil its own assignments. It is the authors' experience and knowledge in this area that enrich the contents of this book.

21 cases of hard rock gold mines are included in this book, and their geology, mining, metallurgy, production and techno-economical indexes in these cases, etc. are introduced, making contents of this book be more perfect and complete.

I believe that the publication of this book will provide a lot of new information for the people who are engaged in or concerned about mining geology in solid mineral resources.

Tu Guangchi

Jan. 1997

Editors' Notes

With the rapid development of gold industry in China, gold mining geology has played an important role in the development of gold mining. Summarizing their experiences in the work engaged in mining geology for many years, especially in the fields of gold mine prospecting exploration, design, construction, production, management, scientific research and teaching etc, the authors discussed in this book comprehensively and systematically (in four parts and fourteen chapters totally) the scope, theory, methods used of gold mining geology and development of gold mining reasonably as well as the role of enhancing the theoretical level of mineral deposit in study. In the book, a lot of geological information on gold mines (deposits) in China are quoted and referred. Based on the conventional knowledge of geology in the mining process, the geological work in the feasibility study in the mine prior construction stage in the design stage in the mine construction stage, and closing of mine stage are also included in the scope of mining geology, broadening the field of mining geology and building-up a perfect conceptual system for mining geology. Ordinary mining geology work is also combined intimately with professional geological work, such as mining hydro-geology, environmental geology etc., adding some new concepts in the book. Twenty one example cases of gold mines in China are listed, introducing their mining geology, deposit geology, mining method, processing technology, production and techno-economical criteria etc. In the appendixes, regulations for gold mining geology work and survey work are given. Therefore, the book is a monograph with a higher both academic value and practical value.

After drafting of this book, it had been lectured of mining geology, speciality of mining geology in Shenyang Institute of Gold for three times and a very good result was obtained. The book can be used as a text book in the speciality of mining geology, the speciality of geology exploration in universities and colleges, and also used as a reference for technical personnels engaged in gold mining geology exploration, mining design and research work, and a reference book for geologists and management personnels in gold mines.

Gold Mining Geology

Zhang Baoren Cun Gui

Contributing Editor Zhao Congxu

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目 录

前 言		
序 言		
第一篇 金矿床基础地质	(1)	
第一章 金的性质	(1)	
第一节 金在元素周期表中的位置	(1)	
第二节 金的物理性质	(2)	
第三节 金的化学性质	(5)	
第四节 金的矿物学性质	(7)	
第二章 金的地球化学性质	(10)	
第一节 金的丰度	(10)	
第二节 金的分布特征	(13)	
第三节 成矿作用中金的地球化学	(31)	
第三章 金矿床成矿机理	(36)	
第一节 金矿床形成的地质条件	(36)	
第二节 金矿床形成的一般特征	(38)	
第三节 几种主要金矿床的成矿作用	(42)	
第四章 金矿床的分类	(62)	
第一节 成因分类	(62)	
第二节 其它分类方案	(69)	
第二篇 岩金矿床地质勘查	(75)	
第五章 岩金矿找矿	(75)	
第一节 概述	(75)	
第二节 找矿地质条件	(78)	
第三节 找矿标志	(80)	
第四节 找矿方法	(82)	
第五节 黄金矿找矿综述	(88)	
第六章 岩金矿床勘探	(94)	
第一节 概述	(94)	
第二节 岩金矿勘探类型	(95)	
第三节 岩金矿床地质勘探方法	(101)	
第四节 岩金矿床地质勘探设计的编制、计划与施工	(110)	
第五节 岩金矿床地质勘探程度	(113)	
第六节 岩金矿床地质勘探报告的编制与审批	(117)	
第三篇 岩金矿山地质	(121)	
第七章 概论	(121)	
第一节 黄金矿山开发程序	(121)	
第二节 黄金矿山地质学的概念	(121)	
第三节 黄金矿山地质在黄金矿山企业的地位和作用	(124)	
第八章 岩金矿山地质工作	(126)	
第一节 岩金矿山建设前期地质工作	(126)	
第二节 岩金矿山建设设计阶段地质工作	(132)	
第三节 岩金矿山基本建设阶段地质工作	(138)	
第四节 岩金矿山生产勘探	(144)	
第五节 岩金矿山采准采矿阶段地质工作	(162)	
第六节 岩金矿山开采结束的地质工作	(169)	
第七节 岩金矿山探采资料验证对比	(172)	

第八节 岩金矿山地质勘探工作 (184)	第二节 岩金矿山开采技术条件的研究 (343)
第九章 岩金矿山地质工作方法 (189)	第三节 岩金矿山岩体移动和地压管理 (345)
第一节 岩金矿山地质编录 ... (189)	第四节 岩金矿山环境地质工作 (348)
第二节 岩金矿石质量及岩矿技术性质的取样和测定 (216)	第五节 岩金矿山矿石选冶试验样品采取的设计和试验内容 (356)
第三节 岩金矿山地质储量计算 (231)	第六节 岩金矿山地质经济问题 (368)
第四节 有关岩金矿山地质报告的编写 (276)	第十二章 岩金矿山地质综合研究 (392)
第十章 岩金矿山地质管理工作 (283)	第一节 概述 (392)
第一节 岩金矿山掘进(剥离)过程中的地质管理工作 (283)	第二节 岩金矿山矿床控矿地质条件的综合研究 (393)
第二节 矿块采准和采场回采过程中的地质管理工作 (285)	第三节 岩金矿山矿体地质的综合研究 (397)
第三节 矿山出矿运输过程中的地质管理工作 (288)	第四节 岩金矿山矿床勘探方法的研究 (400)
第四节 选冶加工过程中的地质管理工作 (290)	第五节 岩金矿山矿区成矿规律的研究 (401)
第五节 岩金矿山矿产开采损失与贫化的计算和管理 (291)	第四篇 砂金矿山地质 (405)
第六节 岩金矿山生产矿量的划分和计算工作 (302)	第十三章 砂金矿勘探基本问题 (405)
第七节 岩金矿山储量管理 ... (308)	第一节 砂金矿勘查工作阶段及任务 (405)
第八节 岩金矿山采掘(剥)技术计划编制中的地质工作 (314)	第二节 砂金矿类型 (409)
第九节 岩金矿山资源保护的地质工作 (327)	第十四章 砂金矿山地质 (411)
第十一章 岩金矿山专门性地质工作 (337)	第一节 砂金矿山地质的基本任务 (411)
第一节 岩金矿山水文地质工作 (337)	第二节 砂金矿山生产勘探 ... (411)
	第三节 砂金矿山采样 (413)
	第四节 砂金矿山地质编录 ... (417)
	第五节 砂金矿山地质储量计算 (418)
	第六节 砂金矿山生产矿量和贫化损失的管理 (426)

附录 A	岩金矿山实例	(429)	附录 E	计算块段截锥体积值的 $F \cdot a$	
附录 B	地质年表	(498)		值表及使用说明	(510)
附录 C	中国构造运动分期及侵入活动、		附录 F	矿(地)层厚度换算表	(512)
	变质作用特征简表	(500)	附录 G	国家矿山地质常用设备参考	
附录 D	岩金矿山地质与测量工作条例			资料	(513)
	(502)			

CONTENTS

PREFACE

FOREWORD

PART I The BASIC GEOLOGY OF GOLD DEPOSIT	(1)
Chapter 1 Properties of Gold	(1)
1.1 Gold in the Periodic Table	(1)
1.2 Physical Properties	(2)
1.3 Chemical Properties	(5)
1.4 Mineralogical Properties	(7)
Chapter 2 Geochemical Properties of Gold	(10)
2.1 Abundance of Gold	(10)
2.2 Distribution Characteristics	(13)
2.3 Geochemistry of Gold in Mineralization	(31)
Chapter 3 Metallogenic Mechanism of Gold Deposit	(36)
3.1 Geological Conditions of Gold Mineralization	(36)
3.2 General Features of Gold Mineralization	(38)
3.3 Metallogeny of Several Types of Gold Deposits	(42)
Chapter 4 Classification of Gold Deposit	(62)
4.1 Formation Classification	(62)
4.2 Other Classification Methods	(69)
PART II GEOLOGICAL PROSPECTING FOR HARD ROCK GOLD DEPOSITS	(75)
Chapter 5 Hard Rock Gold Deposit Prospecting	(75)
5.1 Introduction	(75)
5.2 Geological Prerequisites for Prospecting	(78)
5.3 Prospecting Criteria	(80)
5.4 Prospecting Methods	(82)
5.5 A Review of Hard Rock Gold Deposit Prospecting	(88)
Chapter 6 Hard Rock Gold Deposit Exploration	(94)
6.1 Introduction	(94)
6.2 Types of Hard Rock Gold Deposit Exploration	(95)
6.3 Geological Exploration Methodology on Hard Rock Gold Deposits	(101)
6.4 Drafting, Planning and Construction in Geological Exploration Design of Hard Rock Gold Deposits	(110)
6.5 Degree of Geological Exploration for Hard Rock Gold Deposits	(113)
6.6 Drafting, Examination and Approval of the Geological Exploration Reports of Hard Rock Gold Deposits	(117)
PART III HARD ROCK GOLD MINING GEOLOGY	(121)

Chapter 7	An Introduction to Hard Rock Gold Mining Geology	(121)
7.1	Procedures of Hard Rock Gold Exploitation	(121)
7.2	Concepts in Hard Rock Gold Mining Geology	(121)
7.3	Status and Effect of Hard Rock Gold Mining Geology in Hard Rock Gold Mines Interprise	(124)
Chapter 8	Hard Rock Gold Mining Geological Work	(126)
8.1	Geological Work at the Early Stage of Mine Construction	(126)
8.2	Geological Work at the Design Stage of Mine Construction	(132)
8.3	Geological Work at the Capital Construction Stage	(138)
8.4	Production Exploration	(144)
8.5	Geological Work at the Stage of Stope Development and Mining	(162)
8.6	Geological Work at the Closing Stage of Mining	(169)
8.7	Confirmation and Correlation of Data From Exploration and Mining	(172)
8.8	Geological Exploration Work	(184)
Chapter 9	Methodology of Hard Rock Gold Mining Geology	(189)
9.1	Hard Rock Gold Mining Geological Logging	(189)
9.2	Sampling and Measurement for Ore Quality and Rock Technical Data	(216)
9.3	Geological Reserve Estimation	(231)
9.4	Drafting of Related Hard Rock Gold Mining Geologic Reports	(276)
Chapter 10	Geological Management of Hard Rock Gold Mines	(283)
10.1	Geological Management during Excavation/Stripping Period	(283)
10.2	Geological Management during the Period of Block Opening up and Stopping	(285)
10.3	Geological Management during Transportation Period out of the Mine	(288)
10.4	Geological Management in Ore Dressing Technology	(290)
10.5	Calculation and Management of Mining Loss and Depletion of Hard Rock Gold Mines	(291)
10.6	Classification and Calculation of Production	(302)
10.7	Reserve Control	(308)
10.8	Geological Work during the Drafting of Plans of Excavation/Stripping technology	(314)
10.9	Geological Work of Resources Conversation	(327)
Chapter 11	Geological Professional Work of Hard Rock Gold Mines	(337)
11.1	Hydrogeological Work	(337)
11.2	Research on Technical Mining Conditions	(343)
11.3	Control of Rock Mass Movement and Ground Pressure	(345)
11.4	Mining Geological Work of Mining Environment	(348)
11.5	Design of Sampling in Metallurgical Test and the Test Items	(356)
11.6	Geoeconomics of Hard Rock Gold Mines	(368)
Chapter 12	Comprehensive Geological Research of Hard Rock Gold Mines	(392)
12.1	Introduction	(392)
12.2	Comprehensive Research on Deposit-Controlled Geological Conditions	(393)

12.3	Comprehensive Geological Research on Ore Bodies	(397)
12.4	Research on Exploration Methods of Hard Rock Gold Deposits	(400)
12.5	Research on Metallogenic Law in Hard Rock Gold Mining Area	(401)
PART IV	PLACER GOLD MINING GEOLOGY	(405)
Chapter 13	Basic Aspects of Placer Gold Exploration	(405)
13.1	Stages and Tasks of Placer Gold Prospecting	(405)
13.2	Classification of Placer Gold Deposit	(409)
Chapter 14	Mining Geology of Placer Gold	(411)
14.1	Basic Tasks of Placer Gold Mining Geology	(411)
14.2	Exploration of Gold Placers during Mining	(411)
14.3	Sampling of Gold Placer	(413)
14.4	Geological Logging of Gold Placer	(417)
14.5	Geological Reserve Calculation of Gold Placer	(418)
14.6	Management of Production Ore Tonnage and Depletion Loss of Gold Placer	(426)
 APPENDIXES		
Appendix A	Cases of Hard Rock Gold Mine	(429)
Appendix B	Geologic Chronological Table	(498)
Appendix C	Simplified Table of Tectonic Movement Periods, Intrusion and Metamorphism of China	(500)
Appendix D	Regulations on Hard Rock Gold Mining Geology and Survey	(502)
Appendix E	Table of $F-\alpha$ Value for the Volume Calculation of the Truncated Cone Block and its Usage	(510)
Appendix F	Conversion Table of Stratum/Ore Bed Thickness	(512)
Appendix G	Information of Ordinary Equipment used in Mining Geology in China	(513)

第一篇 金矿床基础地质

第一章 金的性质

第一节 金在元素周期表中的位置

金的各种性质包括物理性质、化学性质、矿物学性质和地球化学性质，主要取决于金的原子构型和它在元素周期表中的相对位置。

金在元素周期表上位于第六周期第一副族(I_B)，与铜、银一起通常称为铜族元素(见图1-1)。金的原子序数为79，是奇数元素，其原子量为197(196.967)g/mol。属4q+1型原子。原子半径与银一样，均为1.44 Å^[2]。

	I _A	II _A	III _B	IV _B	V _B	VI _B	VII _B	VIII	IX	X	XI _B	II _B	III _A	IV _A	V _A	VI _A	VII
1	H																
2													B	C	N	O	F
3	Na	Mg											Al	Si	P	S	Cl
4	K	Ca				Cr	Mn	Fe	Co	Ni	Cu	Zn			As	Se	
5						Mo		Ru	Rh	Pd	Ag			Sr	Sb	Te	
6						W		Os	Ir	Pt	Au	Hg		Pb	Bi		
7						V											

图1-1 金在周期表中的位置

已知金有23个放射性同位素，其质量数为183—201(见表1-1)，但只有原子量为197的金同位素最稳定，可存在于自然界中。其余的均为放射性同位素，半衰期很短，不能稳定存在。金的原子核有79个质子，118个中子，外层有79个电子^[2]。

表1-1 金的同位素^[2]

同位素	半衰期(min)	同位素	半衰期	同位素	半衰期
183Au	50	191Au	3.2s	197Au	3×10 ¹⁶ a(年)
184Au	52	192Au	4.1h	197mAu	7.2s
185Au	7	193Au	15.8h	198Au	2.6963d
186Au	12	194Au	38.5h	198mAu	2.72d
187Au	8	195Au	183d	199Au	3.13d
188Au	8	195mAu	30.6s	200Au	48.4min
189Au	8	196Au	6.18s	201Au	18.7h
190Au	4.7	196mAu	9.7h		