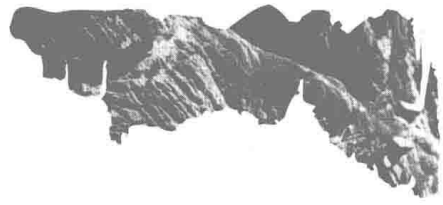
中山大学学术研究丛书

南天山东段韧性剪切带金矿床地质地球化学

李兆麟 孙晓明 杨荣勇等◎著

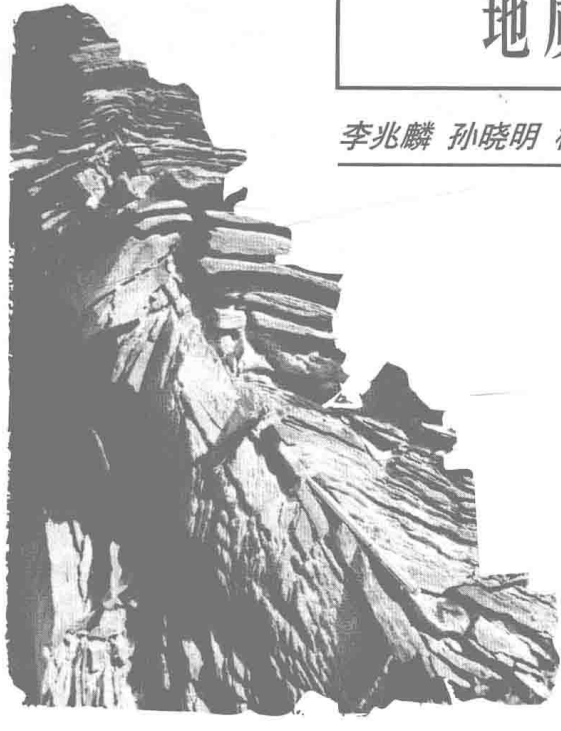
中山大学出版社

中山大学学术研究丛书



南天山东段韧性剪切带金矿床地质地球化学

李兆麟 孙晓明 杨荣勇等◎著



中山大学出版社
·广州·

图书在版编目(CIP)数据

南天山东段韧性剪切带金矿床地质地球化学/李兆麟,孙晓明,杨荣勇等著 .—广州:中山大学出版社,2000.5
ISBN 7-306-01660-1
(中山大学学术研究丛书)

Ⅰ.南…
Ⅱ.①李…　②孙…　③杨…
Ⅲ.①金矿床-地球化学-研究-天山
Ⅳ.P 618.501.7

中国版本图书馆 CIP 数据核字(2000)第 22233 号

中山大学出版社出版发行
(地址:广州市新港西路 135 号　邮编:510275
电话:020-84111998、84037215)
广东新华发行集团股份有限公司经销
中山大学印刷厂印刷
(地址:广州市新港西路 135 号　邮编:510275　电话:020-84111999)
787 毫米×1092 毫米　16 开本　12.75 印张　2 插页　300 千字
2000 年 5 月第 1 版　　2000 年 5 月第 1 次印刷
印数:1—500 册　　定价:23.00 元

中 山 大 学 学 术 研 究 丛 书

国家305项目(85-902-05-05)
国家自然科学基金(49703043)(49873018)
中山大学基础性研究前沿项目(18)
南京大学成矿作用研究国家重点实验室课题基金(049809)
资助项目

本书由中山大学出版基金资助出版

序　一

新疆是个好地方，地域广阔、矿产丰富、是我国少数民族聚居之地。可谓“物华天宝、人杰地灵”。为了加速开发这一地区天赋资源及发展我国西部地区经济，在“七五”期间开始实施国家科技攻关项目，“加速查明新疆矿产资源的地质、地球物理、地球化学综合研究”（简称国家“三〇五”项目）。经过三个五年计划的实施，在辽阔的新疆腹地，我国地质工作者进行了大量深入的矿产资源勘查研究工作，取得了巨大成绩。其中尤以新疆北部研究比较深入，对主要矿产成矿规律及找矿方向作了较详细的研究工作。新疆中部天山构造带是该省重要的贵金属、有色金属成矿带，由于历史的原因研究工作相对比较薄弱，其中尤以南天山地质构造、地层、岩浆活动及其与成矿关系研究，在80年代几近於空白。在90年代初中山大学李兆麟教授等承担国家“三〇五”项目“阿其克布拉克—梧桐沟一带金、铜成矿前景及找矿靶区优选评价”期间，率领专题组多次从南海之滨到新疆东天山戈壁滩进行艰苦的野外地质找矿研究工作，在方圆数千平方公里荒漠，战风沙、斗酷暑、露宿风餐，以找矿为己任，在东天山转战南北，在一片空白区克服重重困难，进行系统的野外找矿及室内研究工作。1992年首次在新疆南天山东段志留—泥盆系中找到了具中大型远景的乔尕山金矿，并确定了中山成矿带的存在，取得了新疆南天山找金历史上的重大突破，这对南天山区域成矿规律及找矿方向的研究具重大意义。

《南天山东段韧性剪切带金矿床地质地球化学》一书是作者在编写的“三〇五”项目研究报告基础上，经过精炼加工、提高写成。本书对南天山东段一带地质、地层、构造、岩浆活动及金的矿化特征进行了系统的研究，取得了一批具有开拓性意义的研究成果：如厘定了中山成矿带的范围，并在其中划分了三种金矿类型；肯定了著名的康古尔塔格剪切带西延到矿区，并识别和命名了三条平行的剪切带；论证了新发现乔尕山金矿属韧性剪切带型金矿，确定了志留—泥盆系是提供金的矿源层，华力西期闪长岩为矿源岩；对金矿床成矿物理化学条件进行系统研究，首次在金矿床含金石英脉中发现熔融包裹体及流体－熔融包裹体；划出了本区10个重要的找金靶区等。本书集中反映了作者历时数年艰苦研究所取得的丰硕成果。

本书是野外考察和室内研究、找矿和矿床地质研究、理论与实际及点与面研究相结合的成功之作。全书立论有据、科学态度严谨、内容丰富、资料

翔实、图文并茂，既在找金实践上有重大突破，又在基础地质研究有所创新。相信本书的问世一定能对新疆地区，尤是南天山金矿的勘查工作以及韧性剪切带与金矿的研究起到十分重要促进作用。

中国科学院院士

郭文魁

1998年7月

序　二

新疆天山构造带是我国西部重要的金、铜多金属成矿带。1958年在与我国新疆西部边陲相邻的乌兹别克斯坦下古生代地层中发现穆龙套超大型金矿床，为世界所瞩目。因此，在我国境内同一天山构造带能否找到相同类型金矿床，长期以来深为我国地质学界所重视。80年代我国地质工作者在天山构造带发现和评价了一批重要的中大型金矿床，著名的如阿希、康古尔、石英滩、齐依求等。但这些矿床均分布于上古生界地层中，而在南天山下古生界地层中金矿床一直处于空白。1992年中山大学李兆麟教授负责“三〇五”项目期间，率领课题组在数千平方公里的戈壁滩上坚持以找矿为中心，实行了化探与基础地质相结合、现场痕金分析与室内测金结合、找矿与研究相结合的工作方法，在优选异常区的基础上依次进行检查评价。于1992年在南天山东段志留—泥盆系中首次成功地找到乔尕山金矿床，并确定了中山成矿带的存在，取得了该区找金矿的历史性突破。其意义不仅在该区填补了金矿床的空白，并论证了南天山东段金矿成矿带所处富矿地层与我国境外南天山构造带金矿床所处层位相一致，这对南天山金矿床区域成矿规律及在我国找寻“穆龙套”型金矿床有重要启迪。此后数年当中在南天山东段相继发现孔雀沟、凌云滩金矿，在西南天山发现一些金矿床，其中萨瓦尔顿金矿床属“穆龙套”型金矿便是一例。

李兆麟教授等新著的《南天山东段韧性剪切带金矿床地质地球化学》是在他们所编写的国家“三〇五”项目（“八五”攻关项目）科研报告《阿其克布拉克—梧桐沟一带金、铜成矿前景及找矿靶区优选评价》基础上，经修改、补充和提炼而成。本书是作者多年艰苦卓越的野外考察和室内研究工作的结晶。作者在下列方面取得了重要成果：

1. 在南天山东段志留—泥盆系中成功地找到乔尕山金矿床，首次在该地区取得了找金的突破，这一突破显然对南天山下古生代地层中进一步找金矿具有开拓性意义。

2. 对矿区韧性剪切构造变形进行了详细的野外考察和镜下研究，肯定了康古尔塔格剪切带西延到研究区内。由北向南首次确定了三条近平行的韧性剪切带。这项工作大大加深了本区剪切带研究的深度。

3. 系统论述了研究区内不同地层、不同岩浆岩、不同构造岩中金及伴生元素的分布与分配特征，确认了志留—泥盆系地层是提供金的矿源层，华

力西期闪长岩为矿源岩，为阐明该区成矿物质来源提供了依据。

4. 对乔尕山金矿床进行了深入系统的成矿流体研究，在其中首次发现了熔融包裹体和流体－熔融包裹体的存在，并确定了成矿流体一系列物理化学性质，这些研究对矿床形成机制提供了重要信息。

5. 确定了10个找矿远景区，为本区进一步找金矿指明了方向。

该书内容丰富，资料翔实，观点新颖，论述有据，是一本优秀学术著作。其中部分研究内容如金元素地球化学与成矿关系、成矿流体物理化学条件研究具有很高的学术水平。相信该书出版一定为新疆地区金矿的勘查和研究起到重要的指导作用，对科研和生产人员也有重要参考价值。

中国科学院院士

刘宝珺

1998年1月

前　言

东天山构造带大地构造位置处于塔里木板块与准噶尔板块的接合地带，是我国重要贵金属、有色金属成矿带。区内东西向韧性剪切带发育，并叠加多期构造影响，出露较完整的古生代地层，并有中酸性火成岩入侵。因此地层、构造、岩浆活动均为本区成矿提供有利条件。80年代在天山构造带自西向东发现了一批有工业价值的金矿床，如阿希、石英滩、康古尔塔格等，但这些金矿床均分布于天山构造带上古生代石炭系中，而下古生代地层金矿床处于空白。但在我国伊犁以西的乌兹别克斯坦东部发现超大型穆龙套金矿床，矿床位于南天山海西地槽下古生代地层中。因此，在我国南天山是否能找到金矿床，深为我国地质工作者所关注。故在本区下古生代地层中开展金矿床找寻及研究，不仅对开发本区矿产资源、填补空白具重要意义，且对整个天山构造带金矿区域成矿规律研究具重大意义。在1992—1995年期间中山大学承担国家“三〇五”项目，在1992年我们在南天山东段志留—泥盆系中首次发现乔尕山韧性剪切带金矿床，取得了该区找金历史上的突破。此后在该成矿带的东西两侧有关单位相继发现孔雀沟金矿及凌云滩金矿，1993年在中国——吉尔吉斯边境发现的萨瓦亚尔顿金矿，属穆龙套型金矿床（郑明华，1998）。因此，本区南天山东段乔尕山金矿床的发现对开展在南天山金矿床区域成矿规律研究具有开拓性意义。

《南天山东段韧性剪切带金矿床地质地球化学》一书是作者们承担国家“三〇五”项目“阿其克布拉克—梧桐沟一带金、铜成矿前景及找矿靶区优选评价”（85—902—05—05），国家自然科学基金项目“新疆乔尕山韧性剪切带金矿中流体作用与成矿关系研究”（49703043）、“河台剪切带金矿床流体成矿作用及深部找矿地球化学研究”（49873018）及中山大学科学基础性研究前沿项目“构造及岩浆作用流体形成、演化与成矿关系”研究成果的基础，历时七年经过进一步综合和提高完成。

本书特点：

1. 在详细的野外及室内研究基础上，在南天山东段志留—泥盆系中找到金矿床，科研储量属中大型，取得了该区金矿找矿的首次突破。

2. 运用地层、构造、地体理论，对该区各时期的地质构造特征、时空演化及形成机制进行研究，认为中天山是塔里木北缘的一个离裂地体，主要由中元古界星星峡群组成。

3. 编绘出1:20万工作区航片解译地质图，通过该区航片解译工作对该区地层、构造地质、古火山机构的研究有重要指导作用。

4. 确定了本区自北而南三条平行的东西向韧性剪切带的存在，肯定了东部康古尔剪切带西延至本区，对三条剪切带宏观及微观构造变形特征进行了详细研究。研究了本区剪切带中主要水－岩反应及变质温度，确定了剪切位移量、古差异应力及应变速率。同时初步确定了本区剪切带活动的时代为240～307Ma，与康古尔剪切带相近。

5. 对各时代地层、岩浆岩进行了详细的岩石学、岩石化学等研究，微量元素、稀土元素、稳定同位素及同位素年龄测定。中天山星星峡群 Rb－Sr 同位素年龄测定为 1 800Ma，是活动大陆边缘产物。志留—泥盆系原岩具复理石杂砂岩的特征，成熟度较低，属大陆岛孤背景产物，地层物质来源于星星峡群。

6. 对本区岩石、矿石进行了较系统的金及微量元素地球化学研究，首次确定本区志留—泥盆系为提供金重要成矿物质的矿源层，闪长岩属矿源岩。本区矿石与变质岩、闪长岩微量元素组合相似，Au 与 As，Sb，Ag 具良好相关性，故可以作为找矿地球化学指示剂。

7. 以充分的证据论证了本区中山成矿带的存在，确定了它是一条与康古尔剪切带近于平行的一条大型剪切带。在矿床地球化学研究基础上，划分出成矿带中三种成因类型金矿床：(1) 剪切带变质热液金矿床（乔尕山南、军营岗）；(2) 剪切带破碎带蚀变岩型金矿床（乔尕山北、孔雀沟）；(3) 火山期后破碎带蚀变岩型金矿床（南庐等）。

8. 对本区主要金矿床（点）进行评价和研究，特别对乔尕山金矿床工作较系统，总结了成矿地质特征、找矿标志和控矿条件，确定了其中主要矿石类型、围岩蚀变等。提出乔尕山南部是志留—泥盆系在受右旋平移韧脆性构造控制，属形成较早的变质热液型金矿，乔尕山北部则受三期构造叠加作用（早期右旋平移剪切，中期由南至北逆掩推覆，后期脆性构造叠加）形成较晚的破碎带蚀变岩型金矿。总结出本区具工业价值韧性剪切破碎带蚀变岩型金矿床四个主要控矿因素：(1) 志留—泥盆系矿源层；(2) 小型中基性侵入岩；(3) 三期构造作用叠加；(4) 热液蚀变作用主要为黄铁绢英岩化、硅化及绿泥石化。其成矿条件中如产出地层岩性、岩浆岩、矿体延伸方向、共生矿物、找矿标志元素 As、金的成色等与穆龙套金矿床相似。

9. 对本区不同类型金矿进行深入的成矿物理化学条件研究，运用矿物中包裹体测定不同类型金矿床（点）成矿温度、压力、成矿流体成分、微量气体成分及成矿溶液浓度，并计算出成矿流体的 f_{O_2}，f_{S_2}。首次在韧性剪切带蚀变岩型金矿床中发现熔融包裹体及流体－熔融包裹体，为探讨流体来源提供重要依据。在本区有工业价值金矿床以包裹体类型复杂为特征，常大量出现熔融包裹体、流体－熔融包裹体、多相包裹体及含 CO_2 包裹体。矿化常与大量包裹体伴生，并具高盐度为特征。这可作为本区金矿找矿标志。

10. 据 1:20 万化探数据资料进行电算处理，编制出 1:20 万新疆阿其克布拉克—梧桐沟金（铜）成矿规律及预测图，共划出找矿预测区，一级 2 个，二级 3 个，三级 3 个，为本区今后找矿指明方向。

上述研究成果反映出南天山东段韧性剪切带金矿床成矿地质条件及地球化学特征，并阐明不同构造、岩浆作用流体形成演化与成矿关系，对探讨本区不同类型金矿床成因及指导找矿具重要意义。

参加本书研究项目的全体人员为了开发边疆矿产资源，多次从南海之滨奔赴新疆戈壁滩进行艰苦的野外工作。同志们肩负重托，不畏艰辛，全力以赴，在数千平方公里荒芜的戈壁滩上克服重重困难，在一片空白区找到了金矿，并进行较深入的研究工作，为新疆人民作出贡献，在新疆找金历史上写下了新的一页。可以说这是凝结着我们全体工作人员数年的血汗和劳动成果，亦是友谊的结晶。

本书是集体劳动成果，参加撰写的有李兆麟、孙晓明、杨荣勇等。具体分工如下：前言李兆麟，第一章吉雄、袁家义、熊德信，第二章孙晓明、熊德信，第三章杨荣勇，第四章杨荣勇、吴建军，第五章李兆麟、吴建军，第六章孙晓明、李兆麟、毛艳华，第七章李兆麟、毛艳华、翟伟，第八章孙晓明、毛艳华、杜海燕，结论李兆麟。全书由李兆麟最后汇总整理、修改定稿。

本书得到国家“三〇五”项目办公室、国家自然科学基金委员会、中山大学学科基础性研究项目的资助。本书有关“三〇五”项目，江西916大队在1992年李师兰、毕承彬、余成就等及1993—1994年王达忠、朱冬梅、彭家驹等曾参加工作；在工作中得到新疆维吾尔自治区政府、国家“三〇五”项目办公室、新疆地质局第十一大队、一大队及卡拉桥盐矿的支持；“三〇五”项目办公室杨旭明主任、马映军主任、张良臣总工程师、李庆昌副主任、吴乃元教授级高工、马济正高工、伍典彬高工、于钟骐高工、王金良工程师的热情帮助与支持；此外得到刘宝珺院士、郑明华教授、栾世伟教授、陶正章教授、胡正刚教授、吴学益研究员、刘德权高工等的大力支持；中山大学出版基金资助本书出版，李慈编辑、李海东编辑、李玉书高工、文拥军工程师为本书出版付出了辛勤劳动；在此表示衷心感谢！

作者衷心感谢郭文魁院士、刘宝珺院士为本书撰写序。

矿产资源开发促进了人类社会的文明，但地质找矿是一项十分艰苦的工作，前人种果后人收，这是地质工作者的天职。当日后我们看到乔尕山金矿能为我国西部矿产资源开发及新疆人民带来幸福，本书成果在南天山指导找矿起到促进作用，我们会感到无限欣慰。

由于水平所限，书中不当之处望读者批评指正。

李兆麟

1999年5月1日

于广州中山大学

Introduction

Located in the juncture area between Tarim plate and Junggar plate, E. Tianshan structural belt is a very important metallogenetic belt of precious and non-ferrous metals in China. The well-developed latitudinal striking ductile shear belt, superimposed multi-stage structural deformation, fairly well-exposed Mesozoic strata and mid-acid intrusive bodies provided advantage conditions for the mineralization in this area. In 1980's, many economically profitable gold deposits, such as, Axi, Shiyingtang, and Kanggurtage et.al., were discovered in this area. They were distributed in Carboniferous strata, but not in Palaeozoic strata. However, in the east area of Uzbekistan, the Mypyhtay ore deposit, a super-large scale gold deposit, was discovered in Palaeozoic strata in E. Tianshan structural belt. Therefore, whether is it possible to discover a gold deposit in Palaeozoic strata in this belt in China territory has aroused general concern of many geologists. For this reason, the exploration and study of gold deposits in Palaeozoic strata in this area is very significant for studying the regional metallogenetic regulation of gold mineralization in this region.

From 1992 to 1995, under the support of State 305 Project, we firstly discovered Qiaogashan gold deposit in S-D strata in this area, made a breakthrough for exploration of gold deposits in old strata in this area. Then, Kongquegou and Lingyuntan gold deposits were also discovered by other researchers at two ends of the E. Tianshan metallogenetic belt. In 1993, Sawayareton gold deposit was discovered at the territory between China and Kirghizia, which belong to Mypyhtay type gold deposit (Zheng Minghua, 1998) . Therefore, the discovery of Qiaogashan gold deposit in eastern position of south Tianshan mountain has a pioneering significance to the research work of the regional gold metallogenetic regulation in this area.

The research work in this book were supported by three projects: "Evaluation of mineralization prospect and target optimization of gold and copper ore deposits in the Aqikebulake and Watonga area" (85-902-05-05, State 305 Project); "Study on relationship between fluid action and mineralization in the Qiaogashan gold deposit"; "Study on the mieralization of fluid and deep geochemistry prospecting He Tai ductile shearzone gold deposit" (49703043, 49873018, National Natural Science Foundation of China), and "the Relationship between fluid formation, evolution and mineralization during tectonic process and magmatic action" (Basic science research foundation of Zhongshan University) .

The major conclusions of the research work in this book are as follows:

1. A middle-large scale gold deposit was discovered in S-D strata in east section of S. Tianshan, which is an important breakthrough in the exploration of gold deposit in this

area.

2. Based on studies on strata, structures, terrains and tectonic evolution in this area, it's concluded that the middle Tianshan mountain is a splitted terrain from the edge of Tarim plate and is composed of middle-Proterozic Xingxingxia group.

3. It has been confirmed that there existed three latitudinal striking parallel ductile shear belts, and the Kanggur ductile shear belt was extended to this area. Studies on the macro- and microscopic structural characteristics of the three shear belts have been made, and the main water-rock interaction, the temperature of metamorphism, the length of shear displacement, the stress difference and the rate of deformation have been estimated. Moreover, the active age of 240-307Ma of the ductile shear belt has been estimated, which is similar to the age of the Kanggur ductile shear belt.

4. Detailed petrological and petrochemical studies, including trace elements, REE, stable isotopic composition analysis and isotopic dating have been carried out on strata and igneous rocks of various ages. Rb-Sr dating shown that the age of Xingxingxia Group is 1800Ma, and it belongs to a continental margin. The protoliths of S-D strata are characteristic by the flysch facies with inferior maturity, its source is Xingxingxia Group.

5. Systematic researches on geochemistry of gold and trace elements shown that the S-D strata are the source bed and the diorite are the source rock of the gold deposits. The trace elements assemblage of ore rocks is similar to that of the metamorphic rocks and diorite. The close correlation between Au and As, Sb, Ag in ore rocks indicates that these elements may be used as guide elements for seeking gold deposit in this area.

6. Based on abundant evidence, we confirmed the existences of Zhongshan metallogentic zone in this region, which belongs to a large scale ductile shear belt and is parallel to the Kanggurtage shear belt. According to geochemical studies, three different genetic types of gold deposits have been recognized: metamorphic hydrothermal type gold deposit occurred in ductile shear belt (the southern Qiaogashan, Junyinggang), brecciated and altered rock type gold deposit occurred in the ductile shear belt and the fractured zone (the northern Qiaogashan and Kongquegou) and brecciated and altered rock type gold deposit occurred in the post volcanic fractured zone (Nanlu deposit et.al.).

7. Fairly systematic evaluating and research on the main gold deposits, especially on the Qiaogashan deposit have been performed in this region. The metallogenetic features, the prospecting criteria and the controlling conditions of gold mineralization have been summarized. The main ore rock types and alteration of around rocks have also been determined. It has been put forward that the metamorphic hydrothermal gold deposits occurred in S-D strata in the southern Qiaogashan were controlled by a early stage dextral and strike-slip ductile-brittle shear zone, while the altered rock type gold deposits in the northern Qiaogashan were controlled by three stages of structural deformation: early stage dextral and strike-slip shear zone, the middle stage overthrust shearing from south to north and the late stage superimposed brittle structures. Besides, four controlling factors of brecciated and altered rock type

gold deposits occurred in ductile shear belt have been summarized: (1) the source bed of S-D strata; (2) the small mid-basic intrusive bodies; (3) the superimposed three stages structures; (4) the main hydrothermal alterations, including pyritization and phyllic alteration, silication, chloritization. The metallogenetic conditions such as the lithology of strata, the composition of igneous rock, the occurrence of the ore body, the ore mineral assemblage, the guide elements for seeking ore deposit and the fineness of gold grains are quite similar to those of Mypyhtay deposit.

8. Systematic studies upon the ore-forming physic-chemical conditions of different types of gold deposits has been carried out. The ore-forming temperature, pressure, the composition of the ore-forming fluid, have been measured. Specially, the melt inclusions and fluid-melt inclusions have been firstly discovered in the altered rock type gold deposits, which may provide important clue to the source of ore-forming components.

Our research results have revealed the ore-forming geological conditions and geochemistry characteristics of the striking ductile shear zone gold ore deposit at the eastern section of southern Tianshan Mountain. The relationships between ore formation and fluid forming and evolution under various tectonic process and magmatism have also been exhibited. It is significantly important for the study on the genesis of the gold ore deposit of different type and may be utilized as a prospecting guidance in the region.

The colleagues of this research project traveled several times between the South China Seacoast and the Gobi desert of Xinjiang to conduct arduous field works to help the development of ore resources of the frontier regions. The team overcame numerous obstacles and worked real hard at the severe conditions through several thousand square kilometers of the remote Gobi desert. As the result of hard teamwork, friendly collaboration, and extensive research works, the gold deposit was discovered in a blank area on the survey map. It is a great contribution to the people of Xinjiang and also a remarkable even of the gold ore prospect history of Xinjiang region.

This book is a result of teamwork. The authors of each chapter are : Introduction Li Zhaolin; Chapter One Ji Xiong, Yuan Jiayi and Xiong Dexin; Chapter Two Sun Xiaoming, and Xiong Dexin; Chapter Three Yang Rongyong; Chapter Four Yang Rongyong and Wu Jianjun; Chapter Five Li Zhaolin and Wu Jianjun; Chapter Six Sun Xiaoming, Li Zhaolin and Mao Yanhua; Chapter Seven Li Zhaolin, Mao Yanhua and Zhai Wei; Chapter Eight Sun Xiaoming, Mao Yanhua and Du Haiyan; Conclusions Li Zhaolin. The book was reviewed, edited and finalized by Li Zhaolin.

This book was sponsored by the National 305 Project, National Natural Science Foundation of China, and The Discipline Fundamental Research Project of Zhongshan University. The authors would like to acknowledge the support and assistance from the Xinjiang Uygur Autonomous Region Government; the National 305 Project Office; the First crew of the 11th Party of Xinjiang Geological Bureau; and the Kalaqiao Salt Mine authority; Mr. Yang Xuming and Mr. Ma Yingjun, Directors of the National 305 Project Office; Mr. Zhang

Liangchen, Chief Engineer; Mr. Li Qingchang, Deputy Director; Mr. Wu Naiyuan, Senior Engineer; Mr. Ma Jizheng, Senior Engineer; Mr. Wu Dianbin, Senior Engineer; Mr. Yu Zhongqi, Senior Engineer; and Mr. Wang Jinliang, Engineer. Our deep gratitude to academician Prof. Liu Baojun, Prof. Zheng Minghua, Prof. Luan Shiwei, Prof. Tao Zhengzhang, Prof. Hu Zhenggang, Prof. Wu Xueyi and Mr. Liu Dequan, Senior Engineer for their valuable support. We would like to thank Ms. Li Ci, Mr. Li Haidong, editors of this book, Mr. Li Yu Shu and Mr. Wen Yongjun, for their hard works. Thanks to the Press Foundation of Zhongshan University for financially support the publishing of this book. Special thanks to academicians Prof. Guo Wenkui and Prof. Liu Baojun who wrote the Preface for our book.

Development of ore deposit resource had promoted the civilization of the humam society. Geological prospecting is an arduous work. Geological works are some how like one generation plans the orchard and the following ones harvest the fruits. We are so proud to be the orchard planners. We are looking forward to seeing our research results help the development of ore deposit resource in the western part of our country, promote and guide the prospecting in sounthern Tianshan Mountain region. We would be gratified when we see the discovery of Qiaogashan Gold Ore Deposit helps the economy of Xinjiang and promotes a better life to the people of Xinjiang.

Li Zhaolin
May 1999
Zhongshan University, Guangzhou

目　　录