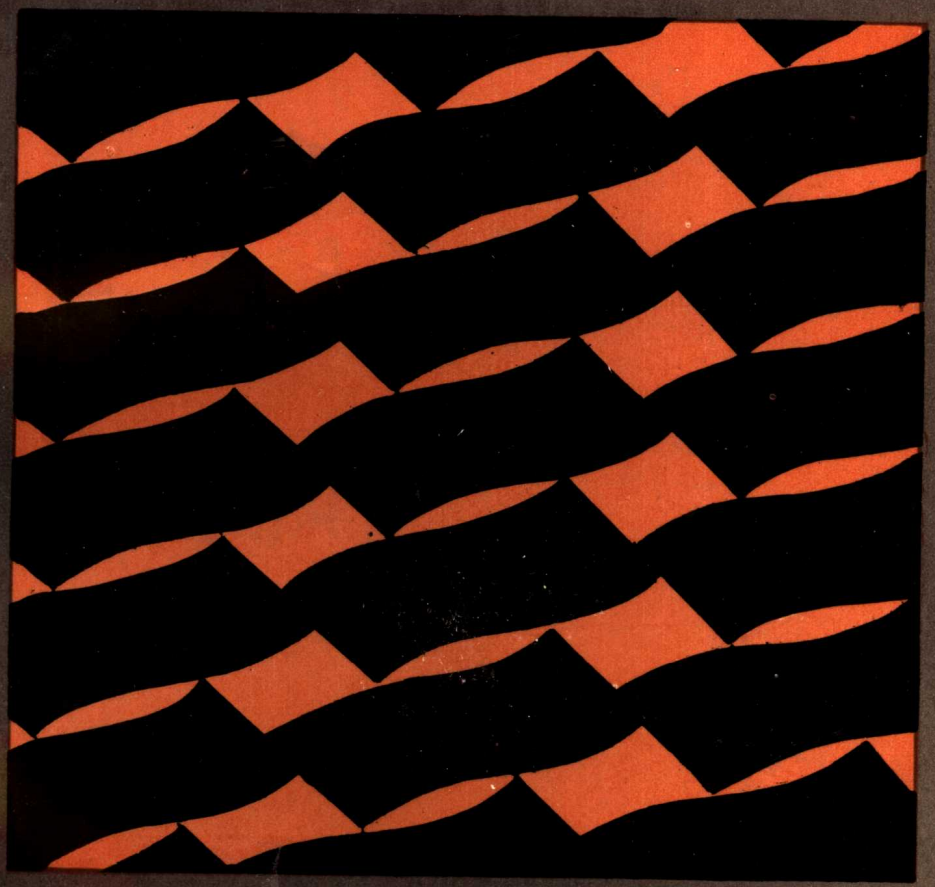
西昌——滇中地区地质矿产科研丛书

康滇灰色片麻岩



地质矿产部成都地质矿产研究所

重庆出版社

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序

西昌—滇中地区，位于我国西南腹地，纵贯川滇两省，北起康定，南迄元江，西以锦屏山—玉龙山为界，东及昭觉—东川一带，面积近10万平方公里。该区系分隔我国南部东西构造区的有特色的构造带和矿产资源重要远景区之一，也是我国西南的重要经济开发区。

经地矿部门和兄弟部门几十年尤其是近二十多年来的共同努力，完成了1:20万区测填图，部分地区开展了1:5万区测工作，并进行了大量的普查勘探工作，探明有储量的矿种71种。其中，铜矿、钒钛磁铁矿、铅锌矿、镍矿、磷矿等，为区内特色矿产，早已驰名中外。该区交通方便，建设条件好，目前已形成为我国初具规模的，以冶金工业为主的重要工业基地。

为进一步满足经济建设对矿产资源的需要，开拓区内地质找矿的新局面，解决区内长期争论的一些关键性的基础地质问题，提高区域地质研究程度，地质矿产部于1980年下达了"西昌—滇中地区地质构造特征及其对铁铜等矿产的控制关系"重点研究项目。

成都地质矿产研究所从1981年开始，组织了所内有关研究室对区内地层、构造、岩石、矿产等关键性的基础地质问题进行了研究，开展了野外考查；同时，在室内进行了大量的分析和测试。对争议较大的前震旦纪含铁、铜的变质地层层序及对比方面的问题，地矿部门与冶金地质部门和有关院校联合组织了攻关。在开展横向联合，组织多学科、多手段联合攻关的同时，又在尊重各学科及"双百方针"指引下，各课题按其各自独具的特色开展了多视角研究，并普遍采用区域性宏观地质与个别地区、个别问题重点解剖相结合的方式，深入进行了命题范畴的整体性综合研究。在项目所涉及的各个领域内都取得了显著的进展。

地层研究方面：前震旦系部分，在详细研究剖面地层组合标志 构造界面、接触关系的基础上，应用微古生物、叠层石、重矿物组合特征及同位素地质年代学等多种手段相结合的方法，弄清了主要地质事件，首次建立了全区性统一地层柱(划分为5群19组)。震旦系的研究，首次论述了早震旦世存在后造山型大陆裂谷；在盐边地区发现南沱期冰成岩，并命名为惠民组；在上震旦统中首次发现大量蠕虫类、藻类及遗迹化石，命名为金沙江生物

群。古生代部分，全面了解和掌握各时代地层的空间分布、沉积特征、生物面貌及其演变规律，进而探讨古生代的地史演化，划分出三个沉积发展阶段，是对西昌—滇中地区古生代地层及古地理概况的又一次全面系统的探讨。中生代地层的研究，证实了祥云地区云南驿组之下确有中三叠世地层的存在，明确了三叠纪时期全区的三个地史演化阶段。

构造研究方面：根据该区晚三叠世以来的中、新生代地质构造的特点，提出了地块边缘构造带的新概念。运用板块构造与多旋回构造相结合的地质理论，对该区地史演化、地质构造特征和铁铜等矿产的分布与成矿规律进行了全面系统的深入讨论，进而指出了找矿方向。在研究过程中，首次鉴别出二叠纪碳酸盐重力流沉积，并由此引申出对该区古构造格架及地史演化的广泛讨论。同时从另一种学术观点出发，对"裂谷作用"的研究，也较前深入了一步：提出本区是裂谷作用与造山作用多旋回发展的典型地区，修正了"攀西大陆裂谷带"的概念，指出真正的裂谷期在晚三叠世早—中期。

岩石学研究方面：首次发现和提出了麻粒岩。将本区片麻状杂岩命名为"康滇灰色片麻岩"，指出其原岩是一套以变质基性火山岩为主的岩石组合，兼有绿岩带和高级变质区的双重特征，属晚太古代和早元古代的产物。同时将其成岩过程分为前构造、同构造和后构造三大变质期，说明康滇灰色片麻岩是这三期变质的综合产物。基性超基性岩研究方面，提出了以物质成分为主的新的岩体类型划分方案，指出各类岩体具有不同的成矿专属性，探讨了有关矿产在岩体中的分布规律，指出康滇地区基性超基性岩是区域上隆、压力降低及不同深度地幔熔融的产物。根据构造与花岗岩类时空分布和成因的依从关系，划分了与本区构造单元相应的混合花岗岩带、重熔花岗岩带和幔源型碱性花岗岩带。其中混合花岗岩带的提出，突破了本区花岗岩类为唯一岩浆成因的传统观点。基于成矿特征及专属性的研究，预测了与各类花岗岩带有关的矿产。

矿床研究方面：从构造演化入手，通过各时代矿床成矿特征、成因机制的研究，阐明了不同时期控矿构造及矿床的空间分布富集规律，划分了七个构造成矿带。对钒钛磁铁矿、铜矿、铅锌矿、锡钨矿、菱铁矿、岩浆硫化铜镍矿等，都分别建立了新的矿床成因模式。对

层控铜矿提出了沉积—成岩—生物、火山喷发沉积—变质、火山喷气沉积—生物、构造—再生等矿床成因模式。在易门铜矿中首次发现了多种生物成矿标志。同时，还提出了"相序结构"、"地球化学障壁"控矿等论据，以大量资料充实了多成因多方式成矿理论。对岩浆型铜镍矿，提出了四种与过去不同的成矿作用方式，建立了三种矿床成因模式。从矿石学、成因矿物学的角度，对区内富铁矿床的成因进行了研究，不但充实了矿床成因论据，而且提供了矿床成因研究的新途径。研究成果还表明，分布于地壳不同层圈的矿产，是地壳演化过程中不同阶段的产物。成矿是在浅部构造与深部构造紧密结合下，在岩浆活动、变质作用和成矿作用的综合地质作用下形成，具有多元成矿的特点。成矿受特定的构造环境控制，不同特点的构造控制了不同类型的矿床。

上述研究成果，经地质矿产部科技司委托地质科学院，于1986年6月20日—6月24日在北京通过评审。评审员有：学部委员、教授郭令智，学部委员、教授董申葆，学部委员、研究员程裕淇，学部委员、教授王鸿祯，研究员路兆洽及同行专家17人。评审认为：这是一份具有国内先进水平的研究成果，是当前西昌—滇中地区地质资料全面系统的总结，反映了最新研究水平；立论新颖、观点明确、逻辑推理严谨，有创新的认识和新的发现，结论可信。建议公开出版，相信这对科研、生产、教学均有重要的参考意义和使用价值。

研究成果，为区内成矿远景区划、矿产预测和新的一轮普查找矿，提供了科学依据。研究中所取得的成绩，是区内广大地质工作者长期辛勤劳动的结晶，是与川、滇两省地矿局、两省地质勘探公司、有关院校和地质队的大力支持分不开的。在此，谨向他们表示感谢！

上述研究成果，分别按地史演化、成矿规律、构造、前震旦系、古生界、中生界、花岗岩、变质岩、基性超基性岩以及铜铁矿床等专题，分为13个分册，辑成《西昌—滇中地区地质矿产科研丛书》陆续出版。丛书在撰写过程中，由于时间短、经验欠缺，不免有错，望读者指教。

徐振新　1986年10月

前　言

本书系地质矿产部部管重点科研项目"西昌—滇中地区地质构造特征及其对铁铜等矿产的控制关系"所属课题之一"康定杂岩的岩石类型及其成因机理"的研究成果。

本课题原计划研究分布于康定—泸定之间的片麻岩类，即狭义的康定杂岩，但由于对比的需要，研究范围向北扩至宝兴杂岩和彭灌杂岩，向南涉猎到石棉、西昌、渡口和滇中的元谋等地区前震旦纪花岗质岩石，大大超出了原定工作范围。从工作的实际需要出发，自北而南，对不同地区所分布的片麻杂岩的研究程度有详有略。通过对全区的野外观察，特别是对康定、宝兴、彭灌等杂岩系统的岩石、矿物和地球化学研究，获得了较丰富的野外资料及测试数据。在此基础上，并综合前人资料，在本书中对该类杂岩的岩石组合、岩石学、矿物学和地球化学及其产出的地质条件，提出了我们的新看法。

此项研究工作始于1981年10月，初期只有贺节明、陈国豪二人断续工作。1983年起先后参加本课题野外及室内研究工作的有杨兆兰、丁朝建、熊代全、闵际坤和刘秋晓同志。本书编写工作的分工如下：贺节明、陈国豪主笔；第一章、第二章和第七章，贺节明；第六章，陈国豪；第三章，杨兆兰、贺节明；第四章长石部分，闵际坤；暗色矿物部分，杨兆兰、刘秋晓；副矿物部分，杨兆兰；第五章，贺节明、刘秋晓；第八章，贺节明、陈国豪。此外，还有刘正南、陈乐尧、傅光学、张计保、王永年、乔时军等同志协助照相及洗印工作，杨俊清、徐丽玲、何军等同志承担了本书全部插图的清绘及植字工作。

北京大学董申葆教授(主审)、地质矿产部成都地质矿产研究所路兆洽、刘俨然两位研究员及矿床地质研究所袁忠信副研究员在百忙中审阅了本书的手稿，提出许多宝贵意见，在此深表感谢。

著　者

1986年10月

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THE KANGDIAN GRAY GNEISSES

Summary

A number of the Precambrian gneissic granitoid complexes are intermittently located along the western and the northern margins of the Yangzi Block, viz., T. K. Huang's Yangtze Paraplatform (T. K. Huang, 1980) and form a narrow belt in shape of a sickle. This belt separates the Block from the Qinling fold system to the north of it and from the Songpan-Garzê fold system to the west. These complexes are Pre-Sinian in age, because they are, in many places, overlain by the Sinian and its covering strata.

Our studies are concentrated on those north-south displayed complexes along the western margin of the Yangzi Block, i. e., from north to south, the Pengguan Complex, the Baoxing Complex, the Kangding Complex, the Muopanshan-Miyi Complex, the Tongde Complex, the Datian Complex, and the Yuanmou Complex. The rocks forming these complexes can lithologically be correlated to the already established gray gneisses around the globe (for examples, the gray gneisses in the Gothåb region, west Greenland and in Saglek area, Labrador, East Canada). They go through from the western part of Sichuan to the central part of Yunnan; sothey are named the Kangdian gray gneisses (as a whole) in this book for the first time.

The conspicuos features of the complexes making up the Kangdian gray gneisses are a considerable amount of detached pieces of dark granular metamorphic rocks in shape of pod, breccia, discontinuous layers, even huge blocks dispersed in gneissic rocks. As a matter of fact, they are all migmatite complexes. Due to different intensities of migmatization, such dark granular rock pieces are sometimes crowded together, sometimes thinly scattered, and even nearly disappearing just like shadows. Then, different kinds of migmatite can be

observed, such as agmatite, stromatite, streaky migmatite, shadowy migmatite and then they may gradually transform into homogenous migmatitic gneisses.

The gneissic rocks noted above are predominantly tonalitic and trondhjemitic migmatites, some are granodioritic and granitic migmatite, and a small amount of them are hornblende plagioclase or two-pyroxene plagioclase gneisses. Among the rock pieces mentioned above, the great majority are metamorphosed basic volcanics. The metamorphosed acidic volcanics, however, come second, only a few belong to the meta-sedimentary rocks, and a few of the larger rock blocks in the gneissic rocks are regarded as migmatized meta-basic and/or-ultrabasic intrusions.

It seems strange that the outcrops of the complexes forming the kangdian gray gneisses and the Kangdian gray gneisses themselves are all elongate in a north-south direction, their foliations and the long axes of the rock pieces in the gneissic rocks, however, strike in east-west direction and dip steeply or vertically. Consequently, the lithologic characters of these complexes usually appears monotonous while observed along an east-west road, but very changeable along a north-south road. Both sides of the Kangdian gray gneisses are bounded by the north-south fault system. It follows thatthe structural line of the Kangdian gray gneisses is originally of east-western direction, evidently, it is the north-south fault system that has uplifted the burried Kangdian gray gneisses. Then, in certain sections, its covers have been eroded away completely, in other sections, they are still left. This process has led to the strange occurrence of the Kangdian gray gneisses. It should also be stressed that though the tonalitic and trondhjemitic migmatites have occupied most of the space within that of the Kangdian gray gneisses, the dark granular metamorphic rock pieces in gneissic rocks are distributed so regularly, that some authors have made them as a stratigraphic sequence named the Kangding Group, including several formations, In addition, the granular rock pieces are always crowded in the central part and gradually get less or even vanish towards the margin of each complex. From the general features discribed, these granular rock pieces should undoubtedly be the relicts of preexisting metamorphic rocks left by migmatization.

The above findings and the detailed studies of the petrography, mineralogy, geochemisty, fluid inclusions, etc., lead us to the conclusion that the Precambrian gray gneisses, at least in the Kangdian area (West Sichuan-Central Yunnan), are transformed from metamorphic sequence with the character of greenstone belt by regional metasomatism, i.e., granitization, having nothing to do

with any kind of magmatism and partial melting of preexisting rocks.

Here, some of the results and discussions in this book are chosen as follows,

Rock Association

1. The metabasite-tonalitic migmatite group, This is a set of gneissic migmatites of tonalitic, granodioritic and granitic composition containing plenty of relicts(rock pieces) of exclusive metabasites. As mentioned above, the tonalitic migmatites are the great majority.

Metabasite is the general name for the relicts of preexisting granular amphibolite and two pyoroxene granulite, as well as hornblende and/or two-pyroxene plagioclase gneisses.

It is nessesary to be noticed that in some places within the Kangdian gray gneisses, the granular amphibolites and two pyroxene granulites are embodied as inclusions in the host gneisses. Both the granular pieces and the host gneisses are similar in mineral and chemical composition only different in texture, structure and colour because of a different grain size. Therefore, they are usually mistaken as migmatites, evidently these phenomena should be the fabric record of two episodes of isochemical metamorphism left in the same kinds of rocks.

2. The meta-acidites—trondhjemites group, This group of rocks includes trondhjemitic and granitic migmatite gneisses with a large number of metaacidic volcanics contained as relicts in different shape in them. The trondhjemitic migmatites take the first place in quantity in this group. The meta-acidites include leptites, e. g., biotite-plagioclase-leptites, biotite-two feldspar-leptites, as well asslightly matamorphosed rhyolites, taking the shapes of bands, pods, and breccias in the gneissic rocks.

3. The metasedimentary rock-granitic migmatite gneiss group, This group is characterized by garnet-bearing granitic migmatite gneiss with discontinuous relict layers of biotite schist and garnet hypersthene granulite and pods of marble.

The first group is widespread all over the area occupied by the Kangdian gray gneisses as main body; the second one takes the second place; the third one only occurs in the southern section.

In certain sections, different rock groups contact one another in such a way that different relicts peculiar to each of them appear alternatively, forming a transitional zone.

Rock-Forming Process

Through detailed petrographic studies it can be seen that the Kangdian gray gneisses are the products of multiple regional metamorphism and metasomatism on the same set of preexisting rocks. According to rock types, characteristics and the regular distribution of the relicts in the gneisses, the Kangdian gray gneisses are formed through at least three episodes; pre-tectonic regional thermal metamorphism; syntectonic regional thermaldynamic metamorphism; and post-tectonic granitization.

1. The pre-tectonic metamorphism: Its products are the introduced granular metamorphic rocks. This kind of metamorphism was carried out for a long period of time under the condition in which the geothermal and static or load pressure are the main factors. The metamorphic reaction had certainly been completed because of the steep geothermal gradient during the Precambrian, so that the mineral grains in the rocks are always equant granular, polygonal with straight boundaries. Therefore, the triple-point texture is well developed and very common. Basic igneous rocks had been transformed to the granular amphibolites and /or two-pyroxene-granulites; and acid igneous rocks, the leptites. All these rocks remained in the gneissic rocks formed after as different sized relicts, in the form of lenses, or breccias, sometimes as large blocks. Commonly in the central part of the remaining blocks, blastophitic texture is still preserved, but it is gradually replaced by a granular texture toward the margin, and further outward to the boundary of the block it becomes gneissosity.

2. The syntectonic metamorphism: After the pre-tectonic metamorphism had ended, the syntectonic metamorphism started along with the east-west folding. During this episode the north-south compressive stress had taken the place of static pressure as main factor, at the same time, the granular pre-tectonic metamorphic rocks had recrystallized to gneisses, the rocks produced by this process are hornblende-and/or two pyroxene-plagioclase-gneisses, and quartz-feldspar-gneisses, etc. Because the compressive stress and the folding did not last long enough, the recrystallization in solid state couldn't be completed entirely, so that a lot of the granular rock relicts had been left over in different shapes and sizes, ranging from megascopic to microscopic. All these rocks produced in both episodes are similar in constituents, even in the composition of plagioclase and mafic minerals, though quite different in fabric. Therefore, the syntectonic metamorphism is also isochemical.

3. Post-tectonic granitization: After the end of the syntectonic metamorphism the hot gaseous-aqueous solution from the deeperpart of the crust and the upper part of the mantle moved upward along the north-south fault system, which was active over a long period of time off and on, and reacted upon the already multiple metamorphosed rocks just mentioned, causing a regional metasomatism and various kinds of migmatites formed.

The study of thin sections indicates that there are two periods of migmatization, Si-metasomatism is the earlier one, which made the metamorphic rocks, especially the metabasites and biotite plagioclase leptites, transform to tonalitic and trondhjemitic migmatites; K-metasomatism is the second one, which made the tonatitic and trondhjemitic migmatites transform to alkali feldspar granitic migmatite. The latter is rather rare in the Kanfdian gray gneisses, because the K-metasomatism was not well developed.

Under the microscope, almost all kinds of the most tremendous characteristies of migmatites and metasomatic textures are well developed. The fluid inclusions in the quartz are all of the gas-liquid phase, no melt inclusions have been found. The homogenization temperature measured from the inclusions is 600-500 ℃ for the tonalitic and trondhjemitic migmatites; 400-300 ℃ for the granitic migmatites.

The Metamorphic Grade and Zoning

As repeatedly noticed above, the regional metamorphic rocks, commonly represented by the relic pieces, are dispersed in the migmatites. The relicts of the same metamorphic grade are always scattered in a large district, viz. planar distribution. There is neither north-south nor east-west zoning and grade variation. Evidently, the relicts of both the Pre-tectonic granular rocks and the syntectonic gneisses have never displayed the features of linear progressive metamorphism. They are consistent with the planar distribution of the same grade metamorphic rocks in which the metamorphic minerals, even the mafic minerals which are extreamely sensitive to the variation of P. t. , commonly keep the same species in almost every rock variation, though the rocks are very changeable in fabric and the proportion of the different minerals. Taking the plagioclase and amphiboles as examples, the plagioclase in both the hornblende two-pyroxene granulite and hornblende two-pyroxene plagioclase gneiss are all labradorites, the amphiboles are all Mg-hornblendes, The P. t condi-