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Research Article

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Ore-controlling structure of gold deposit in southeast Guizhou

Yi Chen

Faculty of Earth Resources, China University of Geosciences, Wuhan, China

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ABSTRACT

Southeast Guizhou is located at the southwestern part of Jiangnan orogenic belt, between the southeast edge of Yangtze Platformand Nanhua Platform, yielding quartz vein- type, altered rock- type, shear zone- type etc. gold deposits. Ore deposits (occurrences) distribute densely with good mineralization condition, andhave great prospecting potential. On the basis of previous studies, ore- controlling structure of gold deposit in southeast Guzihou has been analysed here, the result indicate that the ore- controlling structures include fault, fold, circular and shear structure, almost all the gold deposits (ore occurrences) are related to fault and fold structures, circular structure and shear zone also have close relationship with the formation of gold deposits in southeast Guizhou. The formation of gold deposits is mostly the result of superposition of multiperiodic mineralization. Research on the superposition of multiperiodic and polytype ore-controlling structures is the key to reveal the gold deposit formation in southeast Guizhou.

Keywords: Southeast Guizhou; gold deposit; structure

INTRODUCTION

Since the 1930s,the prospecting and evaluation of gold deposits in Southeast Guizhou has never been interrupted, also including a great deal of geological, geophysical prospecting, chemaical prospecting, and remote sensing interpretation works, new insight for gold deposit type has been obtained: quartz vein, shear zone, altered rock, turbidite rock, and IOCG (iron oxide type of copper or gold deposits) types etc. But it is still lack of systematic researchon main metallogenic ore-controlling mechanism of regional gold deposits, as a result the main prospecting objectsand protential of gold deposits in this area are still far from certain. It is indicated that the formation of gold deposits in Southeast Guizhou is closely related to structures. Based on previous studies, further systematic analysis of the relationship between structural characters and gold mineralization has been worked, providing new materials for metallogenic mechanismresearch of gold deposits in southeast Guizhou.

Geological background

Gold deposits enrichment area in Southeast Guizhou (Tianzhu- Jinping- Liping) is located at the southwestern part of Jiangnan orogenic beltat southeast edge of Yangtze Platform, to the west adjacent to the Yangtze Platform, and to the east connecting with the Nanhua mobile belt, belonging to Xuefeng Mountain basal reverse belt of upper Yangtze Platform (Fig. 1). It had undergone Wuling period, Xuefeng period, Caledonian and Indosinian-Yanshanian etc. multiple times of tectonic movements, an evolution process from continental margin to intracontinent (Cheng, 1994). The ancient basement was formed by Wuling orogeny; after Xuefeng orogeny, the ancient oceanic crust by marginal transitional crust evolution of continental crust; Caledonian movement developed multiple EW trending basement faults, such as in the North Gaoniang basal shear fault zone and in the South Qimengbasal shear fault zone (Fig. 1), and appeared dextral shear actionto strengthen theNE-directed tectonic framework in this area, making the district to be continent during quite a long geological period. Although Hercynian- Indosinian tectonic movements made some local subsidence forming small bays, little influence on the whole area, keeping NE tectonic framework. Until the Yanshan- Himalayan movement, the Pacific Platesubduct obliquely to Asian Continental Plateto form sinistral twist shearing action, making the EW and part of NE structures

in this area undergoing sinistral movement, to generate a series of NNE- directed structures (Lu, 2006).

3 Regional tectonic evolution

Gold deposits of Southeast Guizhou are located in the southwest of Xufeng archicontinent, which is roughly the NW- directed striking arc, also names as Xuefeng arcuate structural belt. Different opinions on Xuefeng Mountain tectonic belt have been proposed, including Ren et al. (1980, 1990) put forward that Xuefeng ancient land was the transitional zone between South China caledonian geosyncline and Yangtze Plateform; Xu (1987) correlated the Regional tectonic patternof Central and southern Appalachians Mountain in North America with that of South China and proposed that tectonic pattern in South China was Mesozoic Alpine type orogenic belt, Jiangnan- Xuefeng archicontinent is a Alpine type remote nappe from Cathysia; Ding et al. (2007) thought it was the Xuefeng thrust uplift belt; Wang (1991) proposed that multi- time and multi-level epicontinental and intracontinental orogenic belts characterised by layer slip structure were the result of all previous orogenesis in Xufeng area, forming the nowadays mountain arcuate mountain belt with the main peak of Xuefeng Mountain, named intracontinental orogenic belt. It had undergone Wuling period, Xuefeng period, Caledonian and Indosinian- Yanshanian tectonic movements, an evolution process from continental margin to intracontinent (Cheng, 1994).

Tectonic development during Wuling period: there has been continental crust basement longer before the sedimentation of Fanjingshan Group and Sibao Group in Xuefeng Mountain area. Under the background of continental crust basement cracking, Fanjingshan and Sibao Groups are dominated by turbidity sediment and ultramafic volcanic magma eruption deposit,constructingflysch formation and spilite-keratophyre formation.There are no outcrops of Neoproterozoic Jixianian strata within research area, but according to the geological characters analysis in adjacent regions, Wuling movement happened at the end of Jixianian, with the background of ocean-continent transition orogenic extrusion, forming duplex fold combination, dominated by thrust-nappe fault, ductile shearzone, and tight fold.

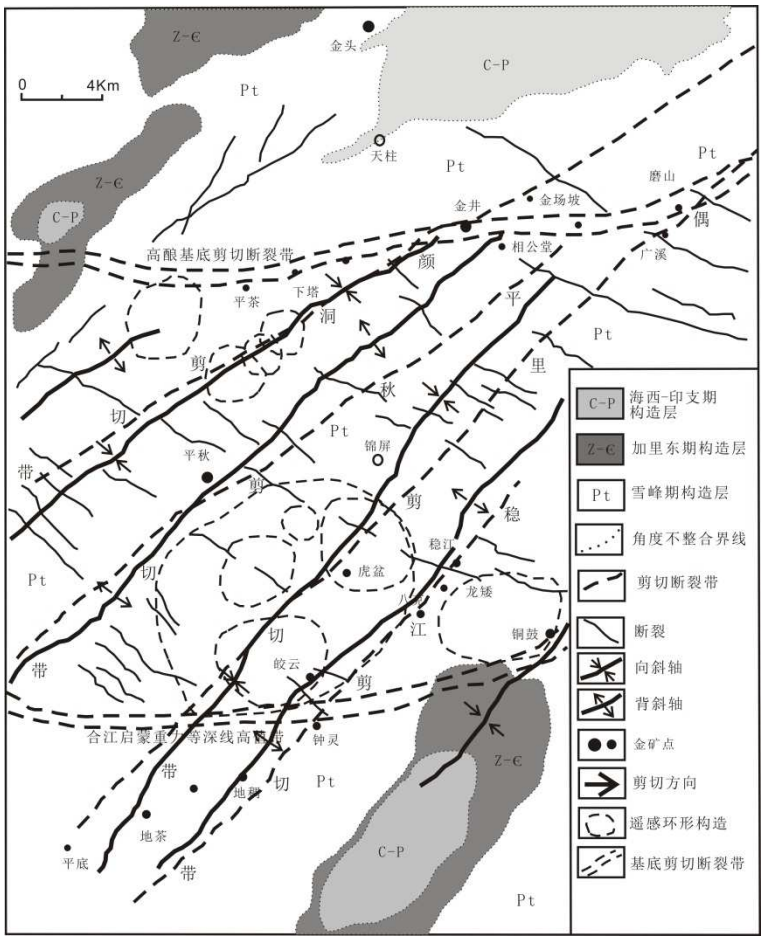

Figure 1 Geologic map of Southeast Guizhou (after Lu, 2005)

Tectonic development during Xufeng period: after Wuling orogenesis, basement rocks were uplifted and eroded, during Xufeng period began to sink to accept deposits, forming giant thick turbidity current deposits (pyroclastic turbidite deposit basin). Xufeng movement is the orogenesis having extensive impact on South China. In this period,

under the NS-directed tectonic stress, Xufeng Mountain shows north uplift and south droppingmovement, EW faulting and partial folding are activated along the joint part, on the east side of Xuefeng ancient continent, subducted from south to the north, left-lateral shear was generated along Jiangshao fault. Xuefeng orogenesis laid out the basic tectonic framework in EW and NE direction(Lu et al., 2005, 2012; Yu, 1994; Wang, 2003) (Fig. 1).

Tectonic development during Caledonian: the continental crust was uplifted after Xuefeng movement, generating strong fold in Jiangnan Plate, strata of late Proterozoic- early Paleozoicoccurred folding deformation, forming NNE-directed Alpine- type fold, thrust- nappe fault, and brittle to transitional shear zone, movement direction is from west to the east. Tectonic setting in research area switched from Qingbankouan chasmic background to ocean-continent transitional orogenic extrusion background. Rocks of Neoproterozoic and earlyPaleozoicetc. had undergone low greenschist lithification and very low regional dynamic metamorphism(Dai et al., 2001).At the same time,more acidic and basic - ultrabasic magma activity might occur in the deep in this area (Tao, 2012).

Indosinian movement ends the large-scale transgression history of South China plate, showing uplift differences in Guizhou. Tectonic evolution during Caledonian: Yanshan movement happened between early and late Cretaceous, most areas of Guizhou was in orogenic extrusion background, result in large-scale fold and fault, forming Jura Mountain-type trough-like fold and thrust- nappe fault, movement direction is from east to the west, as for tectonic line is mainly NEE. At the same time, Yanshan movement overlaid and transformed a part of structural features formed by Caledonian movement (Tao, 2012).Himalayan tectonic evolution: Himalayan crustal movement is mainly characterized by faulting and oscillation,as well as very weak folding.

4 Ore-controlling tectonic characteristics

The majority of the ore deposits (occurrences) in the research area were controlled by NE- directed anticlinorium core and its axial faults of Caledonian, a portion of deposits were controlled by secondary anticline of anticlinorium and its axial faults, as well asbrittle shear zone, while some others were controlled by the speculated deep faults and concealed rock masses.Ore-controlling tectonic characteristics of typical gold deposit(mineralization) zoneare shown in Table 1.

4.1 Fault structure

The existence of two nearly EW deep fault belt constitutes a graben- type main tectonic framework in the research area (Fig. 1). The exposed length of north Kaizhai-Gaoniang basement fault zone is more than 50km, north part of the fault descends from the basement stratigraphic effect,fault displacement is about 200~ 300m, Moshan, Jinchangpo, Jinjing, Xiada and Xianggongtang ore deposits (occurrences)etc.distributealong this fault zone. The dextral shear action of high gravity value zone (Qimeng basement shear fault zone) in the south of Kaili- Taijiang-Jianhe- Qimeng made the district undergoing orogenesis into continent in quite a geological period(Lu, 2005), Tonggu and Zhongling gold deposits (occurrences) distribute along this fault zone.As for the metallogenic relationship between EW fault zone and gold deposits still await for further studies.

A series of NE-NNE faults are the main ore-controlling structures. NE and NNE two sets of fault systemsintersect and unite with each other, dividing the the district into different sizes of rhombus and rectangular blocks. According to the works by Tao (2012), there are mainly two stages for NE and NNE directed faults, Caledonian (closely associated with gold deposits) and Indosinian-Yanshanian (mainly faulting after metallogenic period). Gold deposits in research area are controlled by EW and NE-directed structures formed by Caledonian movement. NW- directed faults transect the tectonic axis of NE-directed fold, generally having left translation nature, for example, Yuankou, Jiangdong, Duma faultsetc. cut NE and NNE- directed folds and faults, which are the typical structures forming after metallogenic period. It is noteworthy that preliminary acquaintance about the output relationship between three sets of main faults and gold deposits has been obtained, but lacking systematic study on the following aspects:①thescale, occurrence, order, development history of faults and the associated conditions of different level faults,change of fault structure and its influence on mineralization;②Combining geological structure research and ore deposit genesis research;③Combining the analysis of the tectonic stress field and geochemical field;④Parsing the geometrical characteristics of the main ore-controlling faulted structure interface, Quantitative analysis of geological, geophysical, geochemical parameters and mineralization of the spatial structure that closely related to mineralization, and its spatial coupling relationship with ore- controlling interface.

4.2 Circular structure

Lu (2005)using TM satellite data and aerial photos, circled out more than 20 circular structures, inclduing concealed rock masses, tectonic basin, and different tectonic superposition causes(Fig. 1).The space position of circular structures is consistent with the linear structural belt, the faults activity site happens to be the favorable place of magmatic activity (intrusion), some gold occurrences also distribute in such palces. To give a reasonable explanation to these ring structures, the comprehensive analysis of shallow geological body should be strengthened, combining

with large scale geophysical interpretationand deep engineering verification, these scientific problems are urgently needed to solve.

Table 1Ore-controlling tectonic characteristics of type gold deposit (mineralization) zone

Gold deposit zones	Main gold deposit concentration areas	gold deposits (occurences)	Deposit (mineralization) type and alteration characteristics	Ore-controlling tectonic characteristics
Kengtou-Laziping	Kengtou-Wengdong	Kengtou, Jintou,Panjin,Wengdong	Quartz vein- type (mainly silicification and arsenopyritization; secondly pyritization, chloritization, carbonatation and sericitization)	CaledonianNE- directed Zhaishang anticlinoriaand the secdonary Kengtou anticline at its west limb, Gongxi fault in axial direction and oblique axial Kengtou fault
	Laziping-Jinyindong	Laziping, Jinyindong, Baojiada		NE trending secdonary folds at southeast limb of Zhaishang anticlinoria: such as Jinyindong anticline, Jinjikou syncline, and Laziping anticline, at the same time it develops of axial or close to axis gold bearing fault belt
Moshan-Xiada	Zhushanchong-Anjia	Zhushanchong, Youmaao, Moshan	Quartz vein- type,a few clastic alteration rock- type(mostly silicification and pyritization; rarely arsenopyritization, chloritization, carbonatation and sericitization)	Caledonian NE- directed Moshan anticlinoria core and nearby several north- east-directed fault tectonic belt and shear- cleavage zones
	Xiada-Jinjing	Xiada, Jinjing, Xianggongtang, Luoyeping		Caledonian NE trending structures andthe mutiperiodic activity of intersection parts of EW-directed Gaoniang basement fault zone
Nanjia-Koudong	Pingqiu	Pingqiu, Songge, Jinchangxi	Quartz vein- type,and alteration rock- type (mainly silicification, pyritization, arsenopyritization, carbonization; next for chloritization, calcilization and sericitization)	Caledonian NE trending Nanjia- Pingqiu anticlinoria and its southeast limb anticlinoria (Songziao anticline, Daiou anticline and Jinchangxi anticline), as well as Nanjia and Pingqiu faults; Secondly controlled by deep EW trending faults and concealed magma rock masses
	Southwestern part: uncertain	Nanjia		
Tianhuashan-Luoli	Bake- Wupo	Bake, Zhongling, Hupen, Mapo	Quartz vein- type (mainly pyritization, arsenopyritization and carbonization; secondlysilicification, chloritization,carbonatation and sericitization)	The core of secondary fold (Bake anticline) at the northwest limb of Caledonian NE- directed Wenjiang anticline and the axial normal fault (longitudinal fault crushing zone) ; Secondly controlled by EW- directed hidden structures (maybe influenced by deep fault and concealed magma rock masses)
	Tianhuashan-Yuantian	Tianhuashan, Xinkaitian, Yuantian		
	Dichou- Luoli	Luoli, Dichou, Dicha, Dachong		
Tonggu-Sanshijiang	Tonggu-Shandong	Tonggu, Nenzhai, Shandong	Quartz vein- type, and clastic alteration rock- type in the deep(mostly silicification, pyritization, arsenopyritization; next forclayization, fading)	Caledonian NE trending Liping and Tonggu anticlinoria; next for inferred EW- directed deep fault and concealed rock masses
	Southwestern part: uncertain	Qiutuan, Sanshijiang, Dapojiao		
Gubang-Shuikou	Gubang-Shuikou	Gubang, Shuikou, Jinkeng	Clastic alteration rock-type(mainly silicification,pyritization, arsenopyritization; secondly chloritization and sericitization)	NNE trending Fulu- Dongtou fault, Gubang fault andthe chucking Gubang anticlinoria

4.3 Fold structures

There are mainly two stages of fold structures in the research area: Caledonian NE- directed basement fold and Yanshanian mantle fold, inheriting of and overlaying on the Caledonian structures. Gold deposits are clearly controlled by fold structures, almost all the gold deposits are related to folds, anticline controlling efffect is the most obvious one, such as Pingqiu and Xianggongtang fold deposits at Pingqiu- Wendou anticline, Dichou and Bake gold

deposits in Wenjiang anticline, Huaqiao and Shandong gold deposits at Leidapo anticline etc. Gold ore bodies (mineralized bodies) mainly yield from interlayer sliding zones (including bedding shear zones)at difffernt positions of folds, turn end of anticline and fault fracture zone or silicified fracture zone at fold limbs (Du, 2010).The researches are relatively weak on detailed division of fold structure causes and morphotypes, systematic study of its ore-controlling position, such as turn end and plunging crown of fold, collapse of anticline axis and sliding crack structure at limbs etc.

4.4 Shear zone structure

There are mainly brittle shear zones in the research area, occasionally occurring a certain size distribution of brittle ductile shear structure, ductile shear zone has not been found, just some ductile shear properties are visible at some positions. Shear zones from northwest to southeast include: Yandong shear zone (with distribution of Jindou and Jinchangpo gold deposits), Moshan shear zone (with distribution of Moshan and Youmaao gold deposits), Pingqiu shear zone (containing Pingqiu gold deposit), Wengjiang shear zone (having Jiaoyun and Hupen gold deposits), and Tonggu shear zone (with distribution of Pingdi, Dichou, Tonggu and Zhongling gold deposits)etc. Gold ore bodies mainly distribute in the complex lens zone and superimposed lens zone with relatively strong deformation, and gold element enrichment and rock deformation degree have obvious relevance (Du, 2010).Whileit is still lack profound studies on structure, fabric, deformation, evolution, geochemistry and paragenetic association of minerals of various shear zones, which should be paid more attention.

CONCLUSION

Based on the comprehensive analysis of the structure characteristics of the gold metallogenic province in Southeast Guizhou, it is concluded that: 1) Structure has obvious control effect to the enrichment of gold deposits in Southeast Guizhou;2) The main ore-controlling structures of gold deposits in Southeast Guizhou include: fault, circular structure, fold and shear zone; 3) Almost all the existing gold deposits are controlled by fold and fault structures, but it still needs further study on the systematic analysis of fault structures and genesis of deposits, and detail research of fold structures; 4) Circular structures have certain relationship with gold mineralization, while only some tentative researches have been done on its ore-controlling effect. Study of circular structures could be used to have a thorough understanding of gold metallogenic mechanismin Southeast Guizhou.5) Gold deposits in Southeast Guizhou are minly the result of mutiperiodic mineralization, superposition of multistage tectonization has important significance on the formation of gold deposits in Southeast Guizhou.

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