ON THE GOLD–DEPOSIT OF SHEARZONE–TYPE AND ITS CLASSIFICATION①

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ABSTRACT

The gold-deposit of shearzone-type (GST) resulting predominantly from shearing is controlled by ductile shearzones, and its general characteristics are discussed in this paper. GST can be classified differently according to its characteristics, and the the authors offer three ways, namely the classification based on the characterisics and genesis of ore-deposits, on the occurrence of shear zones, and on the formation conditions of shear zones.

Key words: Ductile shearzone gold-deposit shearing

1 INTRODUCTION

The authors began researching the Wuchuan-Sihui large fracture zone in Guangdong Province in 1980[1] and resutling in the conclusion that it is a special "structural combination" including various kinds of geologic structures besides ductile shear zones, and thus named Wuchuan-Sihui" Fractural-structural-Assemblage" (FSA), meanwhile the research on relationship between ductile shear zones and gold metallogenesis was carried out by the same authors. The Hetai Gold Ore-field in Guangdong Province discovered recently as a large gold deposit is situated in this Wuchuan-Sihui FSA, controlled by ductile shea- rzones within the FSA. It is believed by the authors that Hetai Gold-deposit should belong to a certain new type of gold deposits, and has been classified first in China as a gold-deposit of "ductile shearzone type" (GST). At the same time it is well recognized all over the world that the gold mineralization depends strongly upon shearzones[2–4], so that according to the idea of GST, some of the previous conventional types of gold-deposits, such as gold-bearing quartz-vein type and others should be actually fallen into the category of GST mentioned above. The Sigma[5] and the Red Lake gold-deposits[6] of Canada, and some gold-bearing quartz-vein deposits in France, India, etc., for instance, have been redetermined recently to be GST, but the classification of their types and the modes of genesis still remain controversial. In this paper, the characteristics and classification of GST will be discussed briefly on the basis of authors' investigation of several examples of GST combined with the results of research on some famous GST at home and abroad, and two examples of newly classified gold-deposits will be given.

①Manuscript received Dec. 5, 1991

2 GENERAL CHARACTERISTICS OF GOLD-DEPOSIT OF DUCTILE SHEARZONE TYPE

GST is defined by the authors as such a gold-depsoit which is structurally controlled by ductile shearzone and its main mechanism of metallogenesis is " shearing deformation". A more systematic investigation recently done by the authors on the relationship between shearzone structures and gold deposits has led to the establishment of a primary metallogenetic model of GST (Fig. 1). The characteristics of different GST, though, differ greatly in its complication and variation owing to its differences in the types of shearzones and metallogenetic conditions, the basic characteristics of GST are similar and can be summarized as follows:

1. Different orders of gold-metallogenesis

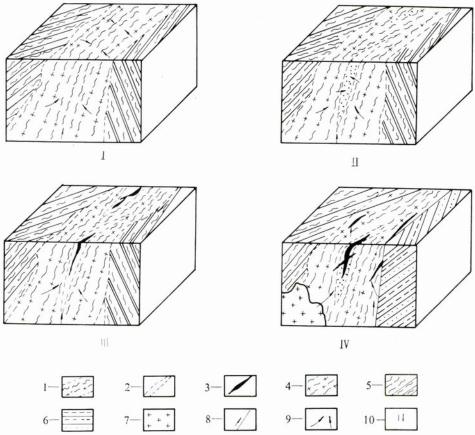

Fig. 1 Schematic diagram illustrating the models and metallogenetic evolution of gold-deposits of shearzone type

1—large high temperature ductile-shearzone; 2—Gold-bearing deep-seated ductile shearzone (mylonite and mylonite-subtype gold-deposit); 3—veinsubtype gold-deposit & superimposed-modified gold-deposit of post-stage; 4—Migmatite & blastomylonite (high-grade matamorphic rock); 5—Schist (low-grade metamorphic rock); 6—Non-metamorphic rock or slightly metamorphosed rock; 7—Intrusious; 8—Faults; 9—Direction of gold-migration; 10—Stage of metallogenetic evolution (I —early stage with preliminary enrichment; ; II —intermediate stage with enrichment and metallogenesis; III —late stage with remetallogenesis ; IV—post stage with modified superimposed metallogenesis are controlled by multiple orders of shearing deformation. A common character of GST at home and abroad is that the gold-deposit is always controlled by the multiple orders of shearzones. The large shearzone controls the source of gold-bearing solutions and distribution of gold-deposits, while the secondary shearzone controls only sites of gold ore-field and ore-deposits.

2. The structure of gold-deposits is controlled by ductile shearzone and different kinds of ductile shearzone control different types of gold-deposit. Most of the ore-deposits occur predominantly within shearzones, only few of them adjacent to or beyond the latter. It is possible to classify gold-deposits into many categories according to the types of shearzones.

3. The shape, occurrence, scale and mineralized position of gold orebodies are controlled by geologic structures of shearzone, and even the intensities of mineralization are directly proportional to shear strain. Ore-bodies occur always at the localities subjected to extension strain, their wallrocks are generally fault rocks mainly consisted of mylonites. Sometimes the mylonites themselves are ore-bearing rocks.

4. The basic types of GST can be subdivided into two groups, i. e., gold-deposit of mylonite subtype (GMS) and that of vein-subtype (GVS). And GMS / GVS can be classified further according to the types of shear zones.

5. Most of GST occur in areas consisting of metamorphic rocks, and large regional shearzone usually shows a high grade phase of metamorphism. This is because of that the metamorphism promotes the reactivation and migration of gold, and the latter has a tendency to migrate from high metamorphic phase toward low one.

6. The metallogensis of GST usually undergoes a long multiple-staged enrichment and may generally be divided into four stages as follows (Fig. 1).

(1) Early-stage with preliminary enrichment: Accompanied with the regional activity of large shearzone, gold matters were often reactivated and filtrated out toward the zones of low grade metamorphism, thus forming primary enrichment (Fig. 1—Ⅰ).

(2) Intermediate-stage with enrichment and metallogenesis: This is the major metallogenetic stage of mylonite-subtype gold-deposit (GMS) forming a deep-seated ductile shear zone consisted mainly of mylonities (Fig. 1—II).

(3) Late-stage with remetallogenesis: After uplifted and strain hardened, the regional shearzone changes into brittle-ductile shearzone, and consists of various kinds of fractures. A gold deposit of shearzone vein-subtype is formed (GVS), when these fractures are filled with ore-bearing veins. (Fig. 1—III).

(4) Post-stage with modified and superimposed metallogenesis: The succeeded activity of shearing happened in more shallow structural-level may lead to the formation of various kinds of fractures and cracks, which may become gold-bearing veins. It may also cause the formation of shoots by reenrichment from modified gold-deposits of both GMS and GVS formed at intermediate and late-stages (Fig. 1—Ⅳ).

It is worthwhile to note that in the late and post-stages mentioned above the more intense hydrothermal activity is presented with hydrothermal alteration, and may sometimes modify the structures of GST formed in early and intermediate stages and blur out their characteristics. This is the main reason why some GST are difficult to recognize.

3 CLASSIFICATION OF GST

GST can be classified differently according to its different characteristics, and the authors here offer three ways, namely classification based on the characteristics and genesis of ore-deposits, on the occurrence of shearzones, and on the formation conditions of shearzooes. A brief description is given below.

3.1 *Based on the Characteristics and Genesis of Ore Deposits*

GST may be subdivided as mentioned above into GMS and GVS. GMS is often controlled by deep-seated shearzones, for which Hetai Gold mine of Guangdong Province offers a typical example. The ore-bearing rocks of this subtype are mylonites, mainly consisted of super-mylonite and common-mylonite①. The essential constituent of ore-minerals is simple, with only a few sulfides. The intensity of wallrock-alteration is very uneven in distribution. The natural gold in the mylonite subtype gold-deposit with high contents of gold and fine-grained size is disseminated within the minerals of mylonite (mainly quartz), or within the microcracks of sulfide grains and within the latter in intragranular and intergranular forms.

Due to the lack of distinct marginal boundaries between ore-body and wallrock, the weak silicified alteration and the undistinct markers, the ore-bodies of GMS are often ignored, and the discovery of Hetai Gold-deposit is a great advance in prospecting this kind of gold-deposit.

The major member of shearzone vein-subtype (GVS) is gold-bearing quartz vein, most of which occur within the shearzone and whose individual one may sometimes extend beyong the zone. Its wallrock is always consisted of mylonites. The minerals occurred in the vein are deformed more strongly and usually accompanied with intense hydrothermal alteration, which may reconstruct the mylonite and shear structurres, leading to the difficulty of recognizing the characteristics of the shearzone.

The deposit of GVS is often superimposed on that of GMS. Sometimes both of them may be developed simultaneously, but according to the references on hand one of them may be usually dominated.

Gold deposits of GVS is formed in the metallogenetic late-stage of the shearzone. Because of the uplifting and strain hardening, the ductile shearzone is progressively changed into brittle-ductile one, which will, by fracturing, form gold-bearing quartz-veins. These fractures, whose distribution is controlled by shearzone, should be equivalent to the five types of fractures proposed by Tchalenko in 1968[7], i. e. R—Riedel shear, R′—conjugate Riedel shear, D— main shear fracture, P—pressure shear, and T—tensional fracture Fig.2 A. The vein occurred along D-fracture is most commonly seen, and those occurred in R-and T-fractures are not so common (Fig.2 B).

3.2 *Based on Occurrence of Shearzone*

GST may be subdivided into two main subtypes, namely gold-deposit of″strike-slip (translation) shearzone subtype″and that of″

①The term ″common-mylonite″ is namd by the authors and equivalent to the"mylonite"in current classification of fault rocks

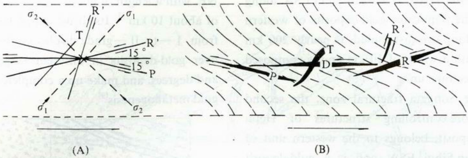

Fig. 2 (A) Fracture-system possibly occurred in a shearzone (modified after Tchalenko, 1968); (B) Vein-arrays possibly occurred in shearzone (after Roberts1987).

nappe (thrust) shearzone subtype". Hetai Gold-deposit, probably a representative of the former, usually has a steeply dipping attidude. Gold-deposit of nappe-shearzone sybtype, a newly notified subtype in the recent years[8], is controlled by the thrust shear-slip zone of nappe-thrust structures, with gently dipping and undulated attitude. The Qingyuan-xinzhou gold-deposit of Guangdong falls into this category.

3.3 *Based on the Formation Conditions of Shearzone*

GST may be divided into two large groups, i. e. gold-deposit of deep-seated shearzone subtype and shallow-seated shearzone subtype. Recently, the research on the ductile shearzone has advanced rapidly and the knowledge about the geologic setting and environment of its formation is quickly enlarged. The previous idea about the ductile shearzone is impossible to embody all of the characteristics shown by the various kinds of ductile shearzones. The authors, therefore, would try to classify the ductile shearzones into three subtypes, i. e. the high temperature shearzone in the super-deep-seated rheologic domain, deep-seated ductile shearzone in the deep-seated ductile domain and the shallow-seated ductile shearzone in the shallow-seated brittle-ductile domain①. Gold-deposits may occur in all the three subtypes of shearzone, but in high-temperature shearzone only the vein-deposits of gold, less related to the ductile shearing, can be formed at the post-stage of metallogenesis. Hetai Gold-deposit, the most important type of gold-deposit, belongs to this deep-seated shearzone subtype. Jinwozi Gold mine of xinjiang may be a representative of gold-deposit of shallow-seated shearzone subtype. In this subtype of shear zone both cataclasite and mylonites occurred together, and gold mineralization is commonly heterogenous. Some gold-deposits of nappeshearzone subtype may belong to that of shallow-seated shearzone subtype.

4 HETAI GOLD DEPOSIT

Hetai Gold-deposit, a well-known large gold-deposit situated at Gaoyao County of Guangdong, is controlled by multiple orders of shearzones. Its first-order of ore-controlling structure is the regional Wuchuan-Sihui FSA and Hetai Gold-deposit is located at its

①Duan, j., et al., 1991, classification of deformation domains in ductile shearzone (in press) northwestern part. Wuchuan-Sihui FSA, along which the important gold-deposits of western Guangdong are distributed, is nearly 200 km long, with a width of 10 km and is composed of five tectonic units.

The Songgui fractural zone, the second order ore-controlling structures of Hetai Gold-deposit, belongs to the western unit of Wuchuan-Sihui FSA, and is a gold-deposit belt, in which more than hundred gold-deposits or mineralization points to date have been found, including four medium to large known gold-deposits.

Hetai ductile shearzone trending N55° E and forming both the third order ore-controlling structures as well as ore-field structures of Hetai Gold-deposit, consists of more than ten secondary echelon shearzones. The gold-bearing ductile shearzone, however, is an ore-controlling fourth-order structure, controlling both the ore-deposit and ore-bodies in the Hetai Gold mine, and belongs to a well-developed deep-seated shearzone in nature[7]. The gold is small-grained to micrograined and is disseminated within nearly bulk shear zone, but the ore-bodies with gold contents reaching productive grade occur only in the common-mylonite and ultramylonite (Fig. 3), thus presenting an evidence that the mineralization is directly proportional to strain intensity.

5 XINZHOU GOLD-DEPOSIT OF NAPPE SHEARZONE SUBTYPE

The Xinzhou Gold-deposit, a newly discovered large gold-deposit in Qingyuan County of Guangdong, is controlled by the Xinzhou thrust-nappe structure. It is also the northward continuation of the gold-bearing belt of Wuchuan-Sihui FSA.

Xinzhou thrust-nappe structure, trends NE, with a length of about 25 km and a width of about 10 km[8]. Its thrust-nappe fault zones from Ⅰ—to Ⅱ—grade display controlling all over gold-deposits in different stages, styles and degrees, and make up a complete series of gold-metallogenesis[9].

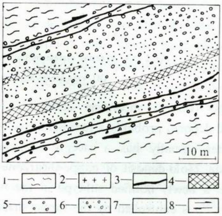

Fig. 3 A Part of geological sketch map of Hetai Gold-deposit, Guangdong

1—Migmatization mica-schist; 2—Granitic veins; 3—Pseudotachylite; 4—Gold ore-bodies; 5—Protomylonite; 6—Mylonite; 7—Ultramylonite; 8—Ductile shearzone and sense of shear.

Ⅰ grade thrust-nappe fault zone (F_{I}) with horizontal attitude (Fig. 4) is the major thrust fault that separates allochthone from autochthone.

Ⅱ grade thrust-nappe fault zone (F_{II}) includes six gently dipping listric thrust faults (Fig. 4), along which albitization and carbonatization are developed.

Ⅲ grade thrust-nappe fault zones (F_{III}) develop on the overturned limbs of main reclined folds within the nappe-sheetsand and Ⅳ grade thrust nappe fractures (F_{IV}) with complicated occurrence are restricted by F_{III}. The gold-mineraliztion in Ⅲ to Ⅳ grade thrust nappe faults commonly taking place on the footwalls of nearby F_{II} faults exhibits as

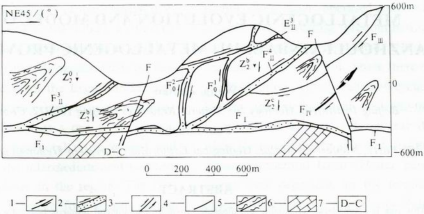

Fig. 4 Comprehensive crosss section of Xinzhou fold- thrust-nappe, illustrating Ⅰ to Ⅳ grade of thrust-nappe structures and the gold-deposits of thrust-nappe shearzone subtype

$Z_2^a\downarrow$ —Lower formation of Upper Sinian; $Z_2^b\downarrow$ —Middle formation of Upper Sinian; $Z_2^c\downarrow$ —Upper formation of Upper Sinian; F_1— Ⅰ gradde faultzone; F_{31}— Ⅱ grade faultzone and serial number; $F_{Ⅲ}$— Ⅲ-grade faultzone; $F_{Ⅳ}$ — Ⅳ grade faultzone; F_{20}—High angle thrust faultzone; F—Thrust-fault of post-nappe stage; 1— Low angle thrust fault; 2— Mylonite and cataclasite zone; 3— Thrust fault; 4— Gold-orebodies and serial number; 5— Dimacaceous quartz-schist; 6—Carbonated mylonite; 7—Devonian to Carboniferous Systems.

gold-bearing cataclastic arsenopyrite-pyrite-veins, cataclastic sulfide-bearing quartz-veins, and mineralized cataclasite from mylonite.

It is thus concluded that although the gold-deposits of shearzone type may be further classified in several ways, the most popular and most important one is its subdivision into two categories based on the occurrence of shearzone, i. e. strike-slip shearzone subtype and nappe-shearzone subtype, and for each of the two subtype Hetai Gold-deposit and Xinzhou Gold-deposit demonstrate respectively a distinct example.

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