Mineralogy Detection and Analysis of an Altered Rock Type Gold Ore Process

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Abstract. Detection and analysis of process mineralogy for altered rock type gold ores produced by a gold mine in Shandong Province, and proved the characteristics of the target element gold and its mineral embedding, gold occurrence status and grain size distribution of gold-containing mineral in the ore sample. The experimental outcomes indicate that the gold-bearing minerals present within the samples predominantly consist of electrum and pure gold. These gold minerals are predominantly found in association with pyrite and arsenopyrite, while a minor proportion is accompanied by quartz. Furthermore, the gold minerals primarily occur in the form of encapsulated gold, exhibiting a fine content of 87.03%. The average dimension of these gold particles is measured to be 5.03 micrometers.

Keywords: altered rock; gold mineral; pyrite; gangue; fine particles

1 Introduction

As mineral detection technology advances and refines continuously, the precision of detection data has undergone significant enhancement. Consequently, process mineralogy has come into widespread application in the examination and analysis of minerals that are challenging to concentrate. This development holds crucial guidance for the efficient exploitation and utilization of mineral resources[1-2]. Automatic mineralogical technology based on scanning electron microscope has gradually become one of the main means of process mineralogy research. In the future, domestic and foreign mineral analysis and identification and process mineralogy research institutions will continue to try to develop mineral automatic analysis system suitable for domestic mineral resources.

Element type gold deposit is a kind of hydrothermal gold deposit. It is mainly the precipitation and deposition of metallogenic hydrothermal fluid in the ore structure and the material in and out with the surrounding surrounding rock, and the water rock reaction to form altered rock. Due to the injection of hydrothermal fluid, the mineral mass accumulates inside or at the edge of the altered rock mass or occurs in the form of similar image. By conducting mineralogical analysis on the altered rock gold ore

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sample, the properties of the target element and the embedding minerals, as well as the occurrence mode and particle size distribution of the target mineral within the sample, have been verified. These findings offer crucial data that underpin subsequent experimental research on the ore and the comprehensive utilization of precious metals[3-7].

2 Sample Multielement Analysis

The alteration rock ore sample was analyzed and the results are shown in Table 1 below.

Table 1. Multi-element analysis results of the samples

Element	Au(g/t)	Ag(g/t)	Cu	Pb	Zn	Fe	S
Grade (%)	1.26	0.86	0.01	0.15	0.21	1.41	0.05
Element	SiO_2	Al_2O_3	MgO	CaO	Na_2O	K_2O	
Grade (%)	37.03	2.52	9.87	23.16	0.18	0.58	

According to the data in Table 1, The primary valuable component within the sample is gold, possessing a concentration of 1.26 grams per tonne, which holds potential for recovery. Conversely, the remaining metal elements exhibit low concentrations and do not possess significant recovery value. The organic carbon content in the ore is 0.44%, and it is necessary to roast the carbon before testing the gold grade.

3 Mineral Composition

Through electron microscope and energy spectrum, the samples contains silver gold ore, gold and silver ore, pyrite, galena and sppherite, gangue, dolomite, calcite, calcite, stone stone, pyene, fluorite, feldspar, mica, etc. The tabular representation of the mineral constituents and their corresponding proportions within the samples is presented in Table 2.

Table 2. Detection results of mineral composition and relative content

Mineral	Content (%)	Mineral	Content (%)
Common pyrite	0.14	Quartz	28.55
Galena	0.16	Feldspar	8.36
Blende	0.35	Mica	2.19
Else	0.10	Calcite	8.36
		Dolomite	42.66
		Gokumite	4.20
		Else	4.93
Subtotal	0.75	Subtotal	99.25

4 Gold Mineral Particle Size Analysis and Dissociation Characteristics

The distribution of gold within the ore samples primarily resides in the forms of electrum and silver-bearing minerals, with respective percentages of 62.37% and 37.63%. The analytical results of the particle sizes of the gold minerals in the samples are displayed in Table 3.

Table 3. Grain ularity analysis of gold minerals in samples

Classify (μm)		Content (%)	Cumulant (%)
Fine grain (-37 + 10)		12.97	12.97
Minuteness	-10+5	38.51	51.48
	-5	48.52	100.00
Average		5.03	

Based on the information presented in Table 3, the gold mineral particles within the sample are relatively fine, possessing an average particle size of 5.03 micrometers, primarily embedded in a fine-to-finer mesh size range. The dissociation properties of the gold minerals in the ore samples are outlined in Table 4.

Table 4. Characteristics of gold mineral dissociation in the samples

Degree of dissociation X	Single-body X=100%	25%≤X< 100%	0<X< 25%	Package X=0	Amount to (%)
Gold mineral	10.70	57.14	8.79	23.37	100.00

According to the test data in the above table, it can be seen that the content of gold minerals in the sample is 10.70%, 23.37% of gold minerals are in package form, and the content of even gold minerals is 65.93%.

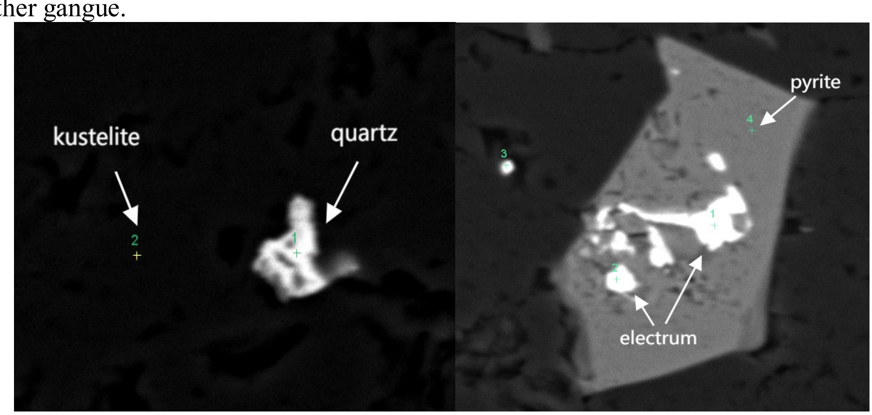
5 Characteristics of Gold Mineral Embedded Cloth

Gold minerals mainly exist in pyrite associated forms such as pyrite, galena and sphalerite, followed by monomer gold forms, and a small amount is associated with quartz and sericite. The mean particle size of the gold mineral measured 5.03 micrometers, with a maximum particle size reaching 16.60 micrometers and a value of 4.41 micrometers noted for another dimension. The statistical data regarding the continuity of gold minerals in the samples are detailed in Table 5, while Figure 1 illustrates the characteristic embedding patterns of the gold minerals.

Table 5. Statistical table of the characteristics of the main gold mineral inserts inthe samples

Mineral	Mono-mer (%)	Commensal (%)				Amount to (%)
		Common pyrite	Galena	Blende	Quartz and other pulsars	
Gold mineral	10.70	47.02	4.65	28.75	8.88	100.00

According to the test data in the above table, it can be seen that the gold minerals are predominantly present in the form of pyrite, with gold mineral content of 47.02%, monomer gold mineral content of 10.70%, 4.65%, 28.75%, and 8.88% with quartz and other gangue.



① Gold and silver mine is wrapped in quartz. ②The silver gold mine is wrapped with pyrite

Fig. 1. Characteristic graph of gold mineral embedding

6 The Main Gold-Containing Mineral Embedding Characteristics

The main sulfide minerals in the samples are pyrite, galenite and sphalerite. The mineral contents are 0.14 %, 0.16 % and 0.35 %, and the average particle sizes are 30.13μm, 7.31μm and 50.65μm, respectively. The specific particle size distribution is shown in Table 6.

Pyrite in the sample mainly exists in the form of poor intergrowth (dissociation degree ≤ 80 % is partially called poor intergrowth), and the specific embedding characteristics are shown in table 7. The specific dissociation degree distribution is shown in Table 8.

Table 6. Particle size distribution of main minerals

Mineral name	Common pyrite		Galena		Blende	
Fraction of grain size(um)	Content(%)	Positive accumulation(%)	Content(%)	Positive accumulation(%)	Content(%)	Positive accumulation(%)
+74	3.65	3.65	0	0	28.68	28.68
-74+38	28.21	31.86	0	0	31.42	60.1
-38+20	33.77	65.63	0	0	14.27	74.37
-20+15	12.54	78.17	8.53	8.53	7.47	81.84
-15+10	10.95	89.12	7.82	16.35	10.34	92.18
-10+5	7.69	96.81	55.07	71.42	5.8	97.98
-5	3.19	100	28.58	100	2.02	100
Mean diameter(um)	30.13		7.31		50.65	

Table 7. List of major mineral laying characteristics

Mineral name	Monomer (%)	The companion (%)		Amount to (%)
		Metal sulfide	Other pulses	
Common pyrite	0.42	16.33	83.25	100
Galena	7.09	4.04	88.87	100
Blende	0.83	39.72	59.45	100

Table 8. Main mineral dissociation analysis lists

Mineral name	Proportion of target minerals(%)					
	0＜X≤10	10＜X≤20	20＜X≤30	30＜X≤40	40＜X≤50	50＜X≤60
Common pyrite	4.45	0.28	0.25	1.01	68.44	3.43
Galena	8.55	6.17	3.09	4.21	15.37	4.95
Blende	0.94	0.86	14.95	45.00	0.79	4.42
Mineral name	Proportion of target minerals(%)					Total
	60＜X≤70	70＜X≤80	80＜X≤90	90＜X＜100	100	
Common pyrite	8.32	3.84	5.72	3.84	0.42	100
Galena	5.25	1.56	6.03	37.73	7.09	100
Blende	0.76	1.37	1.85	28.23	0.83	100

7 Summary

(1) The main valuable element in the altered rock ore sample is gold, and the content is 1.26g / t. The gold minerals are silver gold and gold ore, with gold content of 62.37% and 37.63% respectively; other metal minerals such as pyrite, galena, halblite, and gangue mainly include dolomite, quartz, feldspar, mica, etc.

(2) The gold minerals are predominantly interlinked with pyrite, along with other metallic minerals, and the gold mineral content accounts for 80.42%, the monomer gold mineral content accounts for 10.70%, and the associated with quartz and other gangue gold minerals account for 8.88%.

(3) The proportion of gold minerals existing primarily as free gold amounts to 76.63%, while the fraction encapsulated within other minerals constitutes 23.37%. The average dimension of the gold mineral particles is 5.03 micrometers, with the largest particle measuring 16.60 micrometers in one dimension and 4.41 micrometers in another. It is mainly fine-fine mesh mesh, the fine particle content is 12.97% and the fine particle content is 87.03%.

(4) The gold minerals in the altered rock sample mainly coexist with pyrite and contain some monomer gold minerals, which should be recovered in flotation; 8.88% of gold is associated with quartz, sericite and other gangue, and the grain size is fine, which is difficult to recover in the flotation process. It can be predicted from the process mineralogy testing data of the altered rock ore sample that the flotation recovery rate of the ore is about 90%, This aligns with the data obtained from the production site, suggesting an appropriate enhancement in grinding fineness to enhance the dissociation level of gold and sulfide ore, thereby augmenting gold recovery.

References

1. Zhao Hui, Jin Ziqin. Study on Process Mineralogy of a Gold Ore [J]. Nonferrous Metals (Selected Ore part), 2023(1): 10-15.
2. Ma Chi, Bian Xiaodong, Wang Shoujing, et al. Process Mineralogy of Gold Ores [J]. Gold. 2011,32(10): 47-51.
3. Guo Jinming, Yang Hongying, Tong Linlin, Meng Jing. Study on mineralogy of a copper-molybdenum mixed process in Tibet [J]. Journal of Northeastern University (Natural Science Edition), 2023,44 (8): 1195-1200.
4. Liu Lu, Wang Shoujing, Bian Xiaodong.Research on process mineralogy of a gold ore from Lingbao [J].Gold Mines, 2017(11): 112-115.
5. Zhu Xingfu, Zhang Wenping. Study on the process mineralogy of a gold-containing ore in Shandong province [J]. Shandong Chemical Industry, 2020,49 (22): 128-129.
6. Bahrami A, Abdollahi M, Mirmohammadi M, et al. A process mineralogy approach to study the efficiency of milling of molybdenite circuit processing[J]. Scientific Reports, 2020,10(1):1-4.
7. HRSTKA t, Gottlieb P, SK ála R, et al. Automated Minerals and petrology -- applications of test can integrated mineral analyzer (Tima)[J]. Journal of Geosciences, 2018,63(1): 47-63.