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Process mineralogy study on the graphite surface ore in dandong

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ABSTRACT

The characterization of process mineralogy of surface ore of graphite has been investigated by optical microscope and chemical analysis. The results show that content of metal minerals is little, the valuable mineral are graphite, the main gangue minerals are quartz, sericite, feldspar, white mica and so on. It is adverse to monomer dissociation of graphite because of the dissemination size of the gaphite is middle and fine, and content of fine particle is more. Gangue mineral of sericite and white mica are more, they are similar form of flake or scaly, to graphite, and easy to clay and adhesion on the surface of graphite, so flotation of the graphite is affected seriously. It is likely to influence on the flotability of graphite for graphite crystal occurs bending deformation and this changes arrangement distance of the crystal inside atomic under the action of stress.

KEYWORDS

Graphite; Process mineralogy; Mineral composition; Sericite.

INTRODUCTION

Ore is low-grade fine crystalline graphite mine, the composition of ore are complex, the content of sericite and white mica were higher, whose morphology is similar with target graphite, are flake, scaly, and prone to mud and attached on the surface of graphite, which affects the floatation of graphite. Main metal mineral are metal oxide ore, namely limonite. The content of metal mineral is very low, and it do not have recycling value.

The form of graphite in ore was slab, flake, lamellar, scaly, fibrous and aggregate, which has better crystallization, and formed a band-disseminated distribution in the gangue. The particle size of graphite is relatively small, the width of graphite crystals was in the range of 0.01 0.075 mm, particle size of aggregate is bulky, itparticle size can reach 1 to 5 mm, a small amount of fibrous, hair-like graphite crystals was fine grained, its crystal width was less than 0.01 mm. Part of the graphite in the gangue was dense shaped, crystal gap was filled with tiny gangue minerals, most of the graphite particles aggregate often mixed with tiny gangue mineral, these fine gangue mineral is difficult to disintegrate with graphite, and it is very easy into graphite concentrate, and affect the grade of graphite concentrate and improving of recovery rate.

CHEMICAL ANALYSIS OF RAW ORE

X-ray fluorescence spectrum analysis of raw ore

TABLE 1: X-ray fluorescence spectrum analysis of raw ore

Component	SiO_2	CO_2	Al_2O_3	K_2O	Fe_2O_3	MgO	TiO_2	Na_2O	CuO
Content/%	49.23	24.02	14.42	5.88	3.76	1.27	0.46	0.44	0.0049
Component	**CaO**	**SO_3**	**P_2O_5**	**BaO**	**MnO**	**Rb_2O**	**Cr_2O_3**	**ZrO_2**	**ZnO**
Content/%	0.12	0.11	0.094	0.066	0.036	0.021	0.021	0.014	0.0045

The results of X-ray fluorescence spectrum analysis of raw ore are shown in TABLE 1. Main chemical composition in raw ore is SiO_2, Al_2O_3 and K_2O, and so on, the content of metal elements is very low. The content of CO_2 is higher owing to the existence of graphite in the ore.

Chemical multiple analysis of raw ore

TABLE 2: Results of chemical multiple analysis of raw ore

Component	C	SiO_2	Al_2O_3	K_2O	Na_2O	MgO	CaO	TFe	TiO_2	S
Content/%	2.54	0.35	3.19	0.56	0.052	2.54	0.35	3.19	0.56	0.052

The results of chemical multiple analysis of samples from surface and core are shown in TABLE 2. Graphite is the only valuable ingredients of ore from the table, the other elements have no comprehensive utilization value.

The mineral composition and content of ore

Through identification of ore light and thin by using optical microscope, we found out that valuable minerals in the ore was graphite, and its content is 4.46%, associated with a small amount of pyrite, limonite, pyrrhotite, chalcopyrite, sphalerite and anatase, etc. Graphite is the main recycling mineral, other metal minerals do not have recovery value due to its low content. The gangue minerals are mainly quartz, sericite, followed by feldspar, muscovite, biotite, chlorite, etc, the mineral composition and content of ore are shown in TABLE 3. In addition, the results of particle size determination on recycling mineral graphite are shown in TABLE 4.

TABLE 3: The mineral composition and content of ore

metallic mineral	**pyrite**	**limonite**	**pyrrhotite**	**chalcopyrite**	**sphalerite**	**anatase**	**total**
	0.54	0.51	0.13	0.01	0.01	0.45	1.65
gangue mineral	**quartz**	**sericite**	**feldspar**	**muscovite**	**biotite**	**chlorite**	**total**
	55.46	23.43	7.51	4.69	1.87	0.93	93.89

The TABLE 4 shows that the particle size distribution of graphite in the ore is: above 0.075 mm, the distribution rate was 26.79%, below 0.037 mm, the distribution rate was 15.65%, under 0.01 mm, the distribution rate was 2.38%, at 0.037-0.075 mm, its distribution quantity is higher, which indicates graphite is given priority to disseminate with the fine grained, and its thickness is uniform. But content of fine grain graphite is higher, which is adverse to the monomer dissociation of

graphite, especially for less than 0.01 mm of graphite, it is difficult to completely dissociated from the gangue, which affect the yield of graphite.

TABLE 4: Statistical result of graphite particle size

Particle size/ mm	＞0.15	0.15-0.10	0.10-0.075	0.075-0.053	0.053-0.037	0.037-0.01	＜0.01
Abundance/%	11.43	7.11	8.25	28.44	29.12	13.27	2.38
Total/%	11.43	18.54	26.79	55.23	84.35	97.62	100.00

TEXTURE AND STRUCTURE OF ORE

Texture and structure of ores have important influences on the dressing technology. In general, the structure of the ore mainly refers to the spatial distribution characteristics of minerals and aggregates, while the texture mainly refers to the morphological characteristics of minerals and the aggregates.

Texture of ore

Morphological characteristics of each mineral particles in the ore have important effects on dissociation of minerals. This can be demonstrated by graphite idiomorphic crystal structure in the ore, pyrite hypidiomorphic crystal structure, crystal structure of pyrite and chalcopyrite, and containing structure between two or more minerals, etc.

Graphite in the ore output in the form of sheet, plate or lamellar, crystal shape is in good condition, it form idiomorphic crystal structure. The pyrite in the ore preserved section crystal to be good, and output in the form of hypidiomorphic granular, which form hypidiomorphic crystal structure. Magnetite, chalcopyrite, etc., output in the form of other crystal grain, it do not have any fine crystal, and form other crystal structure. Among ore metals or between metal minerals and gangue minerals are often contained each other, which form containing structures.

Structure of ore

Part of the graphite in the ore aggregate are arranged and white stripe, some are more groups of roughly parallel filling strip, roughly along a direction distribution, forming a banded structure. The metal minerals with thicknesses of granular, such as graphite, pyrite, pyrrhotite, embedded in the gangue mineral, forming disseminated structure. The graphite in the ore puncture in the cracks of mineral, forming vein-filled structure.

THE OUTPUT CHARACTERISTIC OF MAIN MINERAL

Graphite is recycling minerals in the ore, mainly output in the form of plate, sheet, lamellar, scaly, fibrous and aggregate. Its crystal is often good, crystal are arranged in parallel, and often extended the same direction, formed a band-disseminated distribution in the gangue. Part of graphite crystals present bending plate, sheet or hair shape under condition of stress (Figure 1). Particle size of graphite is relatively small, width distribution of graphite crystals is in the range of 0.01 to 0.075 mm. Particle size of the aggregate is relatively bulky, it can reach 1 to 5 mm, a small amount of fibrous or hair-like graphite crystals is fine grained, crystal width is less than 0.01 mm. Part of the graphite present dense shaped in the gangue, crystal gap was filled with tiny gangue minerals, most of particles of the graphite aggregate often mixed with the tiny gangue minerals (Figure 1 d, h). The relationship between graphite and pyrite is close, the common plate or flake graphite particles cross with pyrite, some filled along the edge of pyrite, some filled in the pores of pyrite, and some graphite aggregate encircle with pyrite (Figure 2). The embedded relationship between graphite and limonite is also very close, the graphite cross with limonite, some filled on the edge of limonite. Graphite contact with the edge of limonite, a few small thin plate crystal distributed in limonite (Figure 3). The embedded relationship between graphite and anatase is very simple, graphite filled intergranular of gangue minerals and anatase, and contact with the edge of anatase (Figure 4 a). The embedded relationship between graphite, magnetic pyrite and chalcopyrite is not very close, because content of these three mineral is little, occasionally graphite crystals contact with the edge of pyrrhotite, chalcopyrite or sphalerite.

The pyrite was output in the form of hypidiomorphic granular or small vein, it was disseminated distribution in gangue, and size change is big. Pyrite is often thrust by platy or flake graphite, and its edge and fractures are filled by graphite, part of fine grained pyrite was encircled in the graphite aggregate (Figure 2). Pyrite is often adjacent symbiosis with pyrrhotite and chalcopyrite, holes are often filled with pyrrhotite and chalcopyrite.

Limonite mainly distributed in gangue in the form of granular, irregular shape, crusty and cellular, its disseminated relation is close with graphite. Limonite has often been thrust by graphite, its edge was filled with graphite, and contact with the edge of graphite, small thin flake graphite crystal was distributed in limonite (Figure 3).

The content of anatase in the ore is not much, but its distribution is widespread, it was output in the form of cone column, granular and plate. It was distributed in the gangue, and particle size is not uniform. The broken crack of anatase are well-developed, and it was filled by gangue mineral. The edge of some anatase was filled with flake and fibrous graphite, and show contact relationship with the edge (Figure 4).

Chalcopyrite and sphalerite was rarely in the ore, and it was mainly disseminated distribution in gangue in the form of xenomorphic granular, irregular shape, and the particle size is small. Chalcopyrite and sphalerite are often crystal symbiosis, opacifying sphalerite distributed in the chalcopyrite (Figure 4b). Chalcopyrite and sphalerite did not have very close relations with graphite, only the edge of a small amount of chalcopyrite filled with tiny crystal plate graphite.

The content of quartz in the ore is more, it was output by the form of coarse granular, middle granular and hypidiomorphic granular aggregate, intergranular filled with lamellar white mica and scaly sericite. Intergranular of quartz disseminated with a little black mica, feldspar and chlorite.

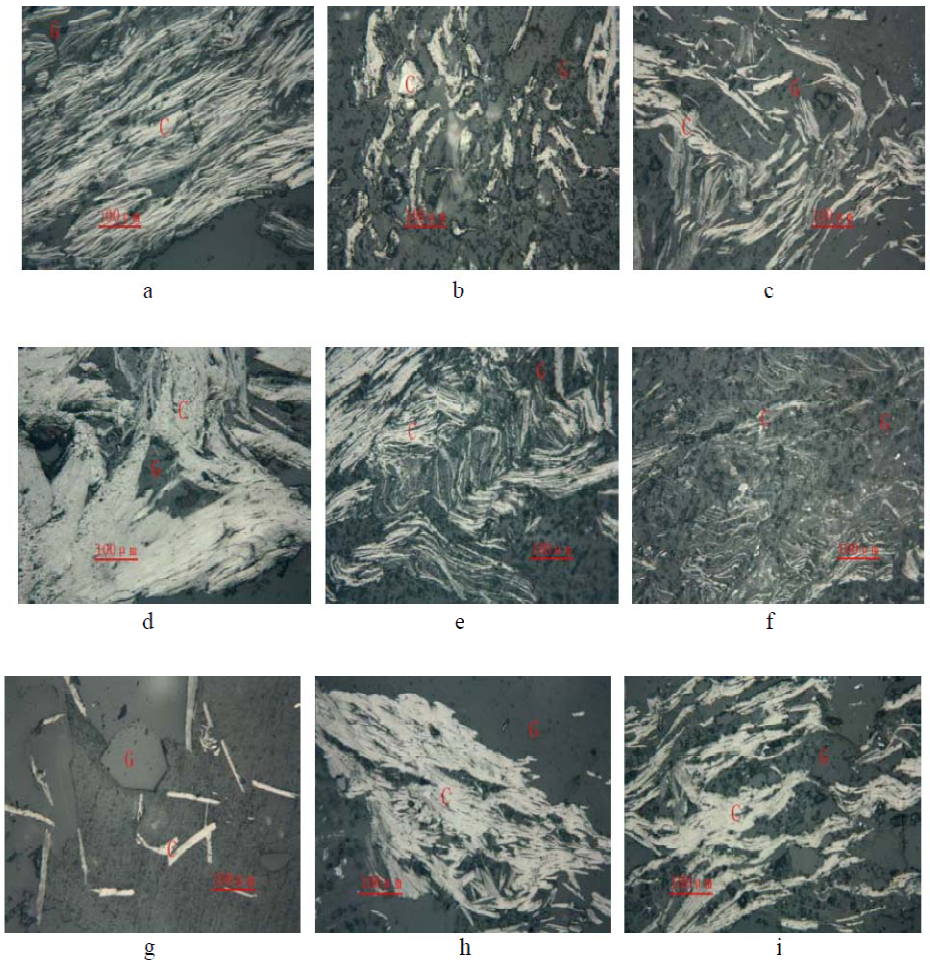
Sericite was output with the form of tiny flake and scaly aggregate, aggregate present strip shape, and the particle was bulky. Some sericite and white mica mixed together, and filled into quartz grain.

White mica in the ore filled silica particles in the form of flake or lamellar, Part of white mica mixed with sericite to form aggregation, it presents a zonal shape in the ore.

Black mica was output with the form of plate. Disseminated in quartz aggregate, part of black mica erosion into chlorite by weathering process.

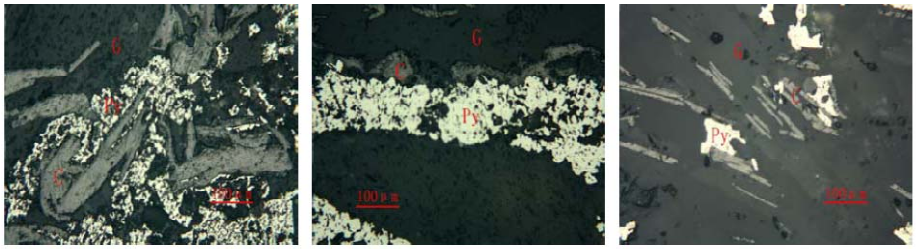
Feldspar was output with the form of idiomorphic or hypidiomorphic plate, and embedded between the quartz grains. Part of the feldspar alternated by weathering to form sericite, and distributed in the feldspar.

Chlorite was formed from biotite by weathering alteration, and its output characteristics are similar with biotite, it disseminated intergranular of quartz in the form of plate, and the granularity is bulky.



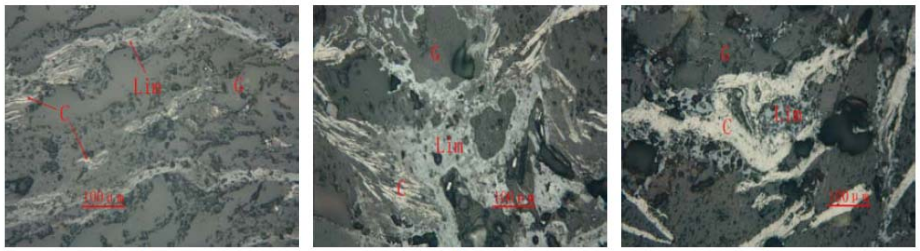
a. graphite (C) distributed with a parallel thin sheet shape; b. scaly graphite aggregate distributed in the gangue (G); c. laminated and lamellar graphite distributed in the gangue; d. graphite was output in the form of tabular aggregate, and the aggregate disseminated in the gangue mineral; e. graphite was output in the form of bending thin sheet or fibrous shape, and it was distributed in the gangue; f. graphite was output in the form of bending thin sheet or hair-like shape; g. the plate-like crystal of graphite distributed in the gangue; h. graphite was output in the form of foliated aggregate, the aggregation contains trace, fine grain gangue minerals; i. graphite present bent plate or lamellar shape, and distributed in the gangue.

Figure 1: The output characteristic of graphite



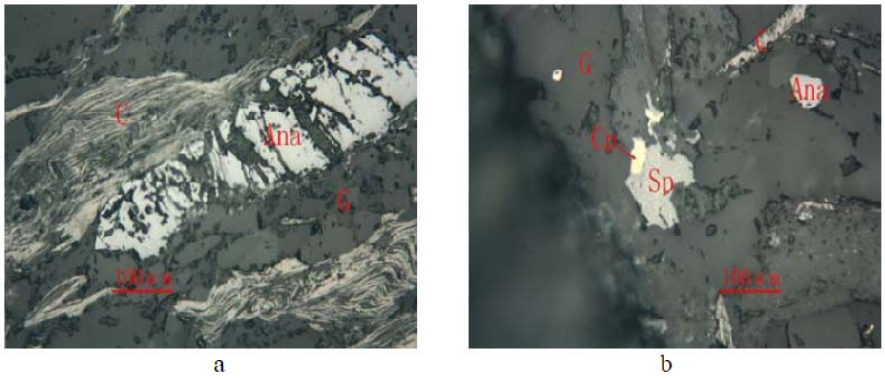
a. Bending plate graphite cross with pyrite (Py), and encircle fine grained pyrite; b. Pyrite aggregate was output in form of vein, and filled graphite in the edge; c. Flake graphite cross with pyrite.

Figure 2: The output characteristic of pyrite



a. thin sheet limonite distributed in gangue; b. thin flake graphite distributed in the edge of limonite; c. graphite cross with limonite particles.

Figure 3: The output characteristic of limonite



a. graphite filled in the edge of anatase (Ana), sphalerite (Sp) and chalcopyrite (Cp) eutectic disseminated in the gangue; b. anatase disseminated in the gangue.

Figure 4: The output characteristic of anatase

CONCLUSION

(1) In this ore, graphite is recycling mineral, other minerals did not have recovery value. Graphite has good flotability, generally it was recycled by using the method of flotation. The main metal mineral in the ore is pyrite, pyrrhotite, chalcopyrite, sphalerite and anatase, etc. The gangue minerals are mainly quartz, sericite, feldspar, Muscovite, biotite, chlorite and so on. Sericite, white mica content in the ore is more, total content reached to 24.46%, they are belong to clay mineral, and easy adhesion on the surface of graphite, and effect graphite flotation recovery. In addition, sericite and white mica are flake and scaly, which have a certain impact on the selection of graphite.

(2) Graphite distributed stripe-impregnated shape in gangue, granular gap was filled with small gangue mineral. Aggregate particles are mixed with the tiny gangue mineral, the fine gangue mineral is difficult to disintegrate with graphite, is easy into graphite concentrate, and lead to the low grade of graphite concentrate. Graphite is also relatively close relationship with pyrite. Graphite is around the pyrite along the side, some fill in the pores of pyrite, some graphite aggregate

encircle pyrite. Dissociation between graphite and pyrite exist certain difficulties, especially graphite filled in the pore of pyrite is difficult to dissociation, and this may have certain influence on the graphite concentrate quality.

(3) The impregnation particle size of graphite in the ore is small, below 0.037 mm, the distribution rate isof 15.65%. In which, the distribution rate was 2.38% under 0.01 mm, the dissociation of fine grain graphite sufficiently from the gangue is difficult, especially tiny graphite particles can hardly be disentangled. Part of graphite crystal under stress occurs bending and deformation, which change the distance of crystal atoms arranged, and is likely to be a certain influence on the flotability of graphite.

REFERENCES

[1] Sui Zumeng; Ore petrology[M], Wuhan, Wuhan university of Technology Press, 10 **(1987)**.
[2] Zhou Leguang; Process Mineralogy[M], Beijing, Metallurgical Industry Press, 163-164 **(2002)**.
[3] Y.Wang, Z.Yuan, Z.Guo et al.; Reduction mechanism of natural ilmenite with graphite[J], Transactions of Nonferrous Metals Society of China, **18(4)**, 962-968 **(2008)**.
[4] D.N.Sutherland, P.Gottlieb; Application of automated quantitative mineralogy in mineral processing[J], Minerals Engineering, **4(7)**, 753-762 **(1991)**.
[5] N.O.Lotter, D.L.Kowal, M.A.Tuzun et al.; Sampling and flotation testing of Sudbury Basin drill core for process mineralogy modelling[J], Minerals engineering, **16(9)**, 857-864 **(2003)**.
[6] Ma Hongwen; Industrial Minerals and Rocks[M], Beijing, Geosciences Press, 217-218 **(2002)**.
[7] Peng Zhenwan, Liu Qingxian, Xu Ming; Mineral Basic[M], Beijing, Geosciences Press, 224 **(2008)**.
[8] K.Knorr; Advances in Quantitative X-ray Mineralogy[J], Process Mineralogy, **10**, 10-12 **(2010)**.
[9] C.L.Evans, E.M.Wightman, E.V.Manlapig et al.; Application of process mineralogy as a tool in sustainable processing[J], Minerals Engineering, **24(12)**, 1242-1248 **(2011)**.
[10] F.J.Luque del Villar, J.D.Pasteris, B.Wopenka et al.; Natural fluid-deposited graphite: mineralogical characteristics and mechanisms of formation[J], American journal of science, **298**, 471-498 **(1998)**.