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A MICROSCOPIC STUDY OF ORES FROM THE RABBITT AND EL ALAMEIN PROPERTIES, GRASSHOPPER MOUNTAIN, TULAMEEN RIVER DISTRICT, BRITISH COLUMBIA.

A report submitted in partial fulfilment of the course in Geology 409 in Geological Engineering, at the University of British Columbia.

J.E. REESOR

University of British Columbia

April, 1949.

A fine job with poor material
RMT

A B S T R A C T

A microscopic study was made of gold ores from Rabbitt and El Alamein properties of Tulameen district in order to discover the occurrence of gold, and with what minerals it was associated.

Insufficient samples were available from Rabbitt property to enable the study to be successful.

Study of samples from El Alamein shows the gold to be associated with pyrrhotite which in places has altered to marcasite.

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I L L U S T R A T I O N S

P A R T A

RABBITT PROPERTY

Introduction

Purpose

1. To determine the minerals present, in particular, the unidentified telluride.

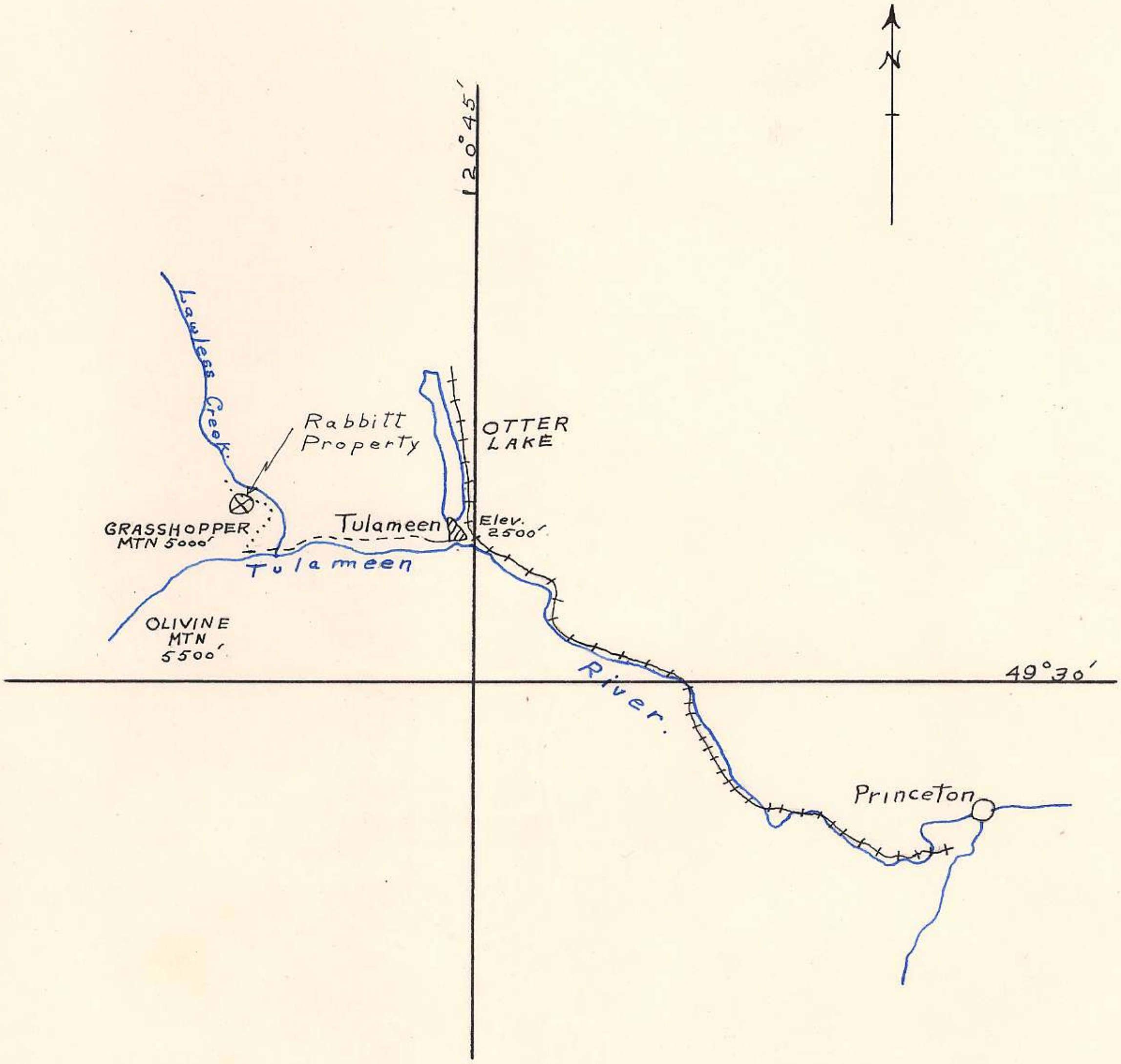
2. To determine the mode of occurrence and association of the gold with the heavy sulphides.

3. To note any peculiarities of the occurrence of gold which may be useful in milling the ore.

Location and Accessibility [x] (2, page 99)

Rabbitt property is located five miles west of Tulameen, in the Similkameen Mining Division. It is on the northeast slope of Grasshopper Mountain at elevation 4,000 feet, about a mile north of the junction of Lawless Creek and Tulameen River (Map page 1 a). The property is accessible by road from Tulameen.

x Numbers in brackets refer to bibliography at end of report.



Map Showing Location of Properties.

Scale 1 in. = 4 miles.

Acknowledegements

The writer gratefully acknowledges the help and cooperation of Dr. R.M. Thompson, of the Department of Geology of the University of British Columbia, in the preparation of this report.

Much information has been obtained from, "Geology and Mineral Deposits of the Princeton Map-Area, British Columbia", Geological Survey of Canada, Memoir 243 by H.M.A. Rice. Specific references are made to this and to other works throughout the text of this report.

Geology (2, page 99)

The deposit occurs in sheared Nicola volcanics of Upper Triassic age. The sheared zone follows, in general the east margin of the Eagle granodiorite, but the regional geology is complicated by intrusion of the Olivene Mountain ultrabasics about one mile southwest of the workings. The mineralization is carried in several steeply dipping, north striking, quartz veins averaging three or four feet in width. Wider sections of the vein are composed of carbonatized, brecciated fragments of wall rock cemented by quartz. Mineralization is "spotty" and much of the vein material is barren.

Macroscopic Mineralization

Only a few deeply weathered and badly shattered samples were available. Minerals identified by examination with a hand lens (x 10) were:

1. Primary
   a) Chalcopyrite
   b) Sphalerite
   c) Galena
   d) Pyrite
   e) Gold
2. Secondary
   a) Limonite
   b) Malachite
   c) Hematite
3. Gangue
   a) Quartz
   b) Particles of Nicola Schists
   c) Calcite

Particles of chalcopyrite up to one centimeter in size were identified on sight, but galena and sphalerite in particles up to two millimeters in size were identified by microchemical methods (3, page 276 and 288). Pyrite is present in only one or two small areas. Pockets of limonite indicate possible former occurrences of pyrite. Gold was found in one small speciman, and is less than one millimeter in size.

Malachite is common as a thin wash on the quartz gangue as an alteration of the chalcopyrite. One or two small pockets of hematite associated with the chalcopyrite were found. Limonite is common apparently as an alteration of chalcopyrite and possibly also of pyrite and sphalerite.

Mineralization is sparse and occurrences of individual minerals vary in size from less than one millimeter to one centimeter in size. The sulphides tend to occur in small groups of associated particles in glassy, sugary quartz gangue. Chalcopyrite is the commonest sulphide and occurs in relatively large particles. The total amount of sulphides varies from nil to perhaps 5%.

The genetic relationships of the minerals cannot be determined from the hand specimen though their occurrence in groups of associated particles may indicate contemporaneous deposition. The particle of gold observed is not associated directly with the other sulphides.

Microscopic Mineralization

Section I and III

(a) Minerals present (in order of abundance)

1. Chalcopyrite $CuFeS_2$

Occupies about 25% of the section and occurs in a quartz gangue, with very irregular boundaries. Particles vary from 100 microns to one centimeter.

2. Hematite Fe_2O_3

Identification: Red streak, deep red internal reflection, and negative reaction to all reagents (3, page 167). Confirmed by microchemical test for iron (3, page 198). It is much softer than ordinary hematite and may be in part limonite.

The hematite occurs in veins, sometimes with a quartz centre, interlaminated with both calcium carbonate and malachite. The veins vary in width from twenty to two hundred microns (photo page 9c).

3. Galena PbS

Identification: Negative to KOH and $HgCl_2$ and KCN. Positive to HNO_3, HCl and $FeCl_3$. Triangular pits, hardness B, isotropic. Confirmed by microchemical tests for galena (3, page 276).

Occurs in very small particles, square to subrounded from 30 microns to 200 microns. At present, exists only in one or two places (Diagram page 9a). Remainder was destroyed in identifying the mineral.

4. Pyrite FeS_2

Occurs in a cluster of anhedral particles varying in size from 20 microns to 400 microns across at only one spot on the section.

5. Gangue

Quartz is the most important gangue mineral. It composes about 75% of the section. In places it forms short discontinuous veins and isolated particles in the chalcopyrite. The quartz is broken by many fractures, which are filled with carbonate, both calcite and malachite.

(b) Mineral Relations

Hematite veins have been formed as a result of progressive replacement and oxidation of chalcopyrite (1, page 98). In some veins the alteration has begun about a lens or short discontinuous vein or inclusion of quartz in the chalcopyrite. Then alternate bands of carbonate and hematite have been deposited. Invariably, as shown by etching and by reflected light from the arc lamp the outer edge of the veins is now calcite or malachite.

Inter-relations of the galena and chalcopyrite is more difficult to assess. They occur closely associated, surrounded by carbonate gangue and are in turn surrounded by quartz. They may possibly be contemporary.

The discontinuous veins of quartz in the chalcopyrite may indicate two generations of quartz, one previous to the chalcopyrite and one after the chalcopyrite.

Section II

(a) Minerals present (in order of abundance)

1. Sphalerite ZnS

Identification: Negative to all reagents except aqua regia and HNO_3. Confirmed by microchemical test for Zinc (3, page 187). Appears to be non-internal reflecting.

Occurs in continuous, irregular patches from two millimeters to five millimeters in length. It contains about 5% of exsolved chalcopyrite. oriented or otherwise?

2. Chalcopyrite $CuFeS_2$

Occurs as irregular patches varying in size from one-half millimeter to two or three millimeters in length. Checked by scratching to ascertain that no gold was present.

3. Hematite Fe_2O_3

Veins and surrounds chalcopyrite as in section I.

4. Covellite CuS

Identification: Indigo blue color in polished section. Intense red, white, and blue polarization colors.

It occurs as irregular veinlets about 20 microns in width and as small blebs up to 50 microns in diameter in the sphalerite.

5. Gangue

Quartz is the main gangue. It is veined with carbonate.

(b) Mineral relations

The chalcopyrite and sphalerite have a mutual boundary suggesting that they are contemporaneous (Diagram page 9b).

Covellite veins, and is later than, thesphalerite. It may have been formed as an alteration product of the exsolved chalcopyrite in the sphalerite.

Hematite again veins and replaces the chalcopyrite (Diagram page 9a).

Paragenesis

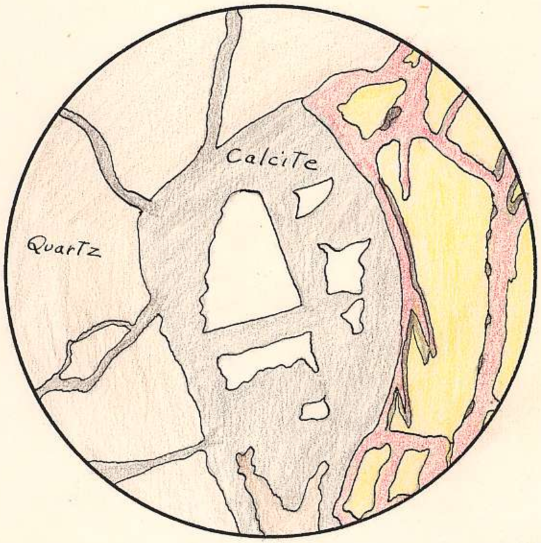
Due to sparse mineralization a definite sequence of mineralization is impossible to establish. From the hand specimens the sulphides appear to be related in groups of isolated minerals in the gangue. They may therefore be contemporaneous. The mutual boundary between chalcopyrite and sphalerite in section II adds evidence to this conclusion (Diagram page 9b). Quartz, on the slender, basis of a few discontinuous veins in chalcopyrite, may be of two generations. Gold was not found in the polished sections and the occurrence in the hand specimen did not show any relationship to the other sulphides.

Carbonates, hematite, and covellite are secondary and are therefore later than the primary sulphides.

Conclusions

The original objective of finding how the gold occurs and with what minerals has not been successful in this investigation. This has been due in part to the discontinuous nature of the occurrence of the heavy sulphides and in part to the poverty of the specimens available for study. Further study is therefore warranted only if sufficient material is available to find the gold in the hand specimen. For according to Rice (2, page 99) properties on this mountain contain the gold in pockets which are much later than the heavy sulphide minerals. The occurrence of the sulphides in the sample would not therefore be sufficient to indicate the presence of gold nor the as yet unidentified telluride mineral.

The Occurrence of Galena



x 75

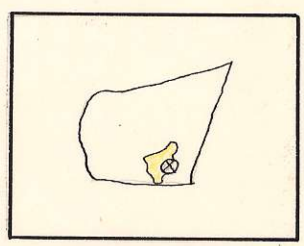
Chalcopyrite

Hematite

Galena

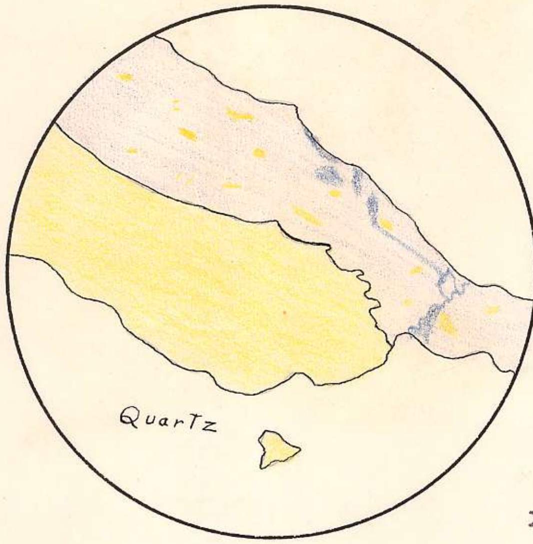
Calcite

Quartz



Section 1
Location

Diagram showing relation of Chalcopyrite, Sphalerite and Covellite



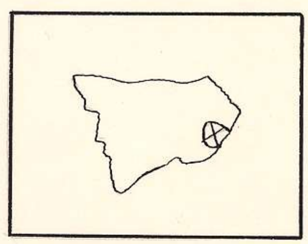
x 75

Chalcopyrite

Sphalerite

Covellite

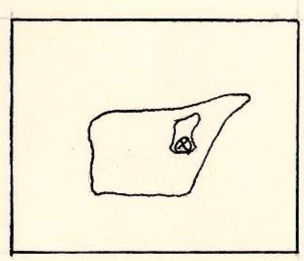
Quartz



Section 2
Location

0.25 mm.

Photo showing the veining and replacement of Chalcopyrite (white) by banded Hematite (dark gray) and Carbonate (black).



Section I
Location

PART B

EL ALAMEIN

Introduction

Purpose

1. To find out if the massive gold mineralization is associated with tellurides or heavy sulphide minerals.

2. To note any peculiarities of the occurrence of gold which may be of use in milling the ore.

Location and Accessibility

Nothing is known of the exact location of this property other than that it occurs in the general vicinity of Rabbitt property on Grasshopper Mountain [x].

In addition, nothing is known of the geology or history of the deposit.

Acknowledgements

The writer wishes to acknowledge the help and co-operation of Dr. R.M. Thompson in the study of this ore and in the preparation of the report.

Thanks is also due to Mr. J.A. Donnan who helped select specimens for polishing and who super-polished two of the samples.

x By converaation with Dr. R.M.Thompson.

Macroscopic Mineralization

Massive gold mineralization occurs in the calcite gangue in discontinuous stringers one-quarter to one-half inch in length. Other concentrations of gold in stringers occur along ribbons of the wall rock schist, in particular at the contact of the schist and calcite, ~~but also in the schist~~. Quartz is present in minor amounts in the gold bearing specimens, on the other hand no gold is present in the more massive quartz specimens.

Pyrite occurs as euhedral crystals in the grey, bleached wall rock and in the calcite but is apparently not directly related to, nor in contact with, the gold. Some of the surfaces of the pyrite crystals appear to be built up of fine laminae.

Another mineral occurs in very small quantity in association with the gold, but cannot be identified in the hand specimen.

Microscopic Mineralization

Section III

(a) Minerals present (in order of abundance)

1. Marcasite FeS_2

Occurs in small anhedral patches one to two millimeters in diameter and in prismatic veinlets up to 800 microns long. These are probably pseudomorphs after pyrrhotite.

2. Gold Au

Occurs in small patches, which vary in size from 50 microns to one or two millimeters. It occurs only in one small area of the section.

3. Pyrrhotite (Fe_n $S_{n \neq 1}$)

Identification:

Color: white, with very slight pink tinge.

Habit: prismatic euhedral crystals.

Hardness: C≠

Anistorpic: colors gray and brown.

Slightly magnetic.

Etch:	$HgCl_2$	(-)
	KOH	(≠)
	$FeCl_3$	(-)
	KCN	(-)
	HCl	(-)
	HNO_3	(≠)

The last two reactions were interefered with by calcite gangue.

These properties indicate pyrrhotite.

Since particles were so small, this result was checked by x-ray by Dr. R.M. Thompson.

Isolated, prismatic particles of pyrrhotite range in length from 2 to 600 microns. It is always associated with the calcite, but the largest concentrations appear to be at the contact of the calcite and the quartz particles.

4. Gangue Minerals

Calcite with included particles of brecciated quartz forms the gangue minerals.

(b) <u>Mineral Relations</u>

Gold and pyrrhotite commonly occur together. In general, they exhibit mutual boundaries, showing that deposition has been contemporaneous. In one or two cases gold cuts both gangue and pyrrhotite but this is not sufficient evidence to say that gold has been later. In most cases the gold and the gold-pyrrhotite are concentrated in the greatest amounts at the borders of the angular quartz particles and the calcite.

Pyrrhotite and marcasite are associated in many places. This association appears to be due to interactions of solutions to form marcasite from pyrrhotite. The reaction depends on the acidity of the carbonatizing or mineralizing solutions (3, page 101; 4, page 181). This would explain the occurrence of the fine grained intergrowths of carbonate and marcasite and the existence of marcasite as a pseudomorph of pyrrhotite. The occurrence of carbonate particles throughout the other minerals points also to a late stage of carbonatization which broke down the pyrrhotite.

The order of mineralization has therefore probably been as follows:

1. Brecciation of quartz veins.

2. Introduction of calcite which has probably brought in the pyrrhotite and gold.

3. Further carbonatization, resulting in the breakdown of pyrrhotite to form marcasite.

Section II

Pyrite FeS_2

Occurs as euhedral crystals in the finely banded silicified gangue. Some of the cubes which have been polished parallel to the crystal face show a very smooth surface.

Section IV

This section shows the pyrrhotite and massive gold. The occurrence of pyrrhotite in small, discontinuous veinlets from one patch of gold to the next indicates that both have been deposited at the same time. Mutual boundaries between the pyrrhotite and gold add further evidence to this conclusion.

Two other sections, I and V, were examined in order to find out if other minerals were associated with the gold. Nothing new was found in either section.

Paragenesis

The paragenesis is best shown in section III and is discussed under that section. In summary, the paragenesis is as follows:

1. Introduction of quartz veins followed by brecciation.
2. Introduction of calcite, pyrrhotite, and gold.

3. Further carbonatization and alteration of pyrrhotite to marcasite.
4. The pyrite found in the silicified wall rock gangue is apparently not associated with the above and may be previous to or subsequent to the main mineralization.

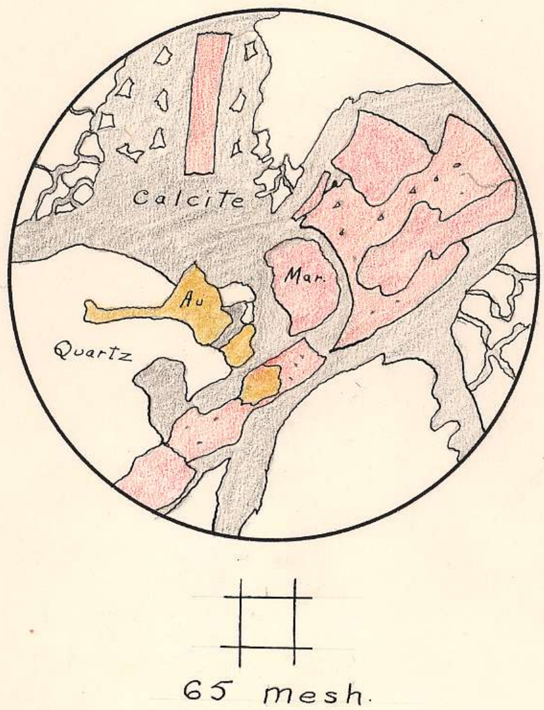
Conclusions

Since no geology is known and since only one diagnostic mineral is present it is difficult to classify the deposit accurately.

Further, pyrrhotite alone is not a good temperature indicator. Allen, Crenshaw, and Johnston have shown that it can be formed at temperatures ranging from 80° to 225° C (4, page 217). Elsewhere, however, they show the change from pyrrhotite to ~~pyrite~~ marcasite to take place at about 550°C at a partial pressure of 5 millimeters of sulphur in hydrogen sulphide (4, page 216). Since this result depends on pressure no conclusion may be reached as to what has occurred in this deposit.

The presence of pyrrhotite may cause excessive consumption of cyanide in treatment of the ore since the loosely held sulphur atoms in the pyrrhotite appear to promote solution of the sulphide in, and reaction with, the cyanide solution (1, page 136). However, it is unlikely that there is sufficient pyrrhotite in this deposit, judging solely by specimens available, to raise the cost of treatment very much. If the ore were ground to -150 mesh, most of the gold would be freed for subsequent cyanidation.

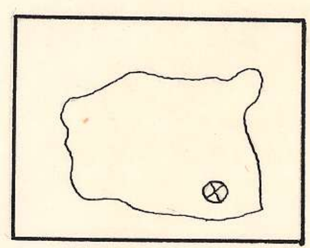
Diagram showing relationship of Marcasite, Pyrrhotite and Gold.



Gold

Marcasite

Pyrrhotite



Section 3
Location

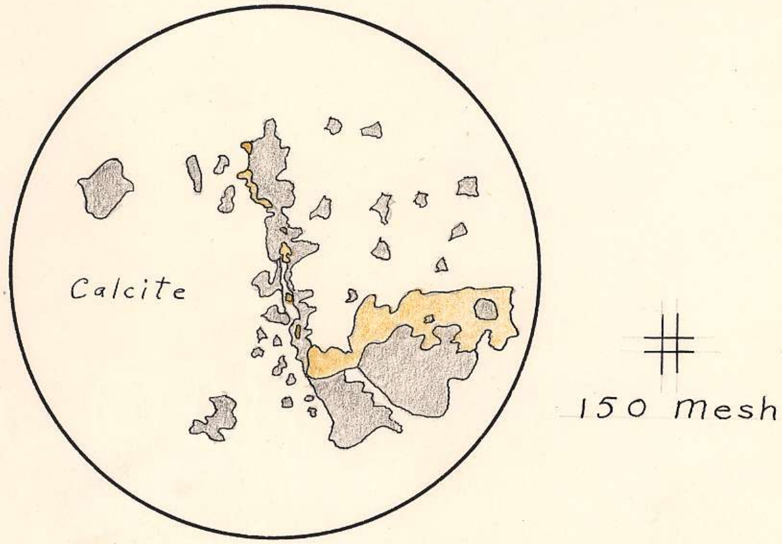
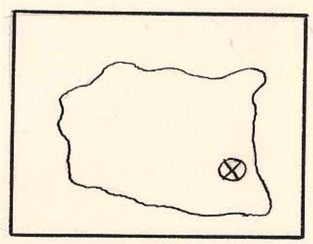


Diagram showing relationship of Gold and Quartz

Gold

Quartz



Section 3
Location

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