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Epigenetic - Cavity Filling Process a Genetic Model of Barytess Deposits of Rajgarh, District Alwar (Rajasthan)

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Abstract – Present study has been confined to Rajgarh belt of District Alwar (Rajasthan). Specimens of Barytess and host rock were collected from this area for the purpose of study. Barytess ($BaSO_4$) is the principal barium mineral of commerce containing 65.7% BaO and 34.3 % SO_3 with specific gravity of 4.5. In earth crust the barium value varies from 300 to 500 ppm in igneous rocks, basalt contains 100 ppm barium, granites contain 700 to 800 ppm, syenites and more potassic igneous rocks contain as much as 3000 to 5000 ppm. Barium is too large in ionic radii (1.34 A) and only major element of compare able ionic size with K^+ (1.33A). There for normally in bistite and potash felspar barium can substitute for potassium.

Hydrothermal solution may extract barium from various types of rocks and the solutions are enriched in barium as compared to potassium. The sulphides of barium are soluble in water and easily transportable. Barium is there for mobilized, transported and concentrated under the different conditions. The chemical model of precipitation of berytes of Rajgarh area shows a series of oxidation- rduction reactions. Sulphides in country rocks and adjoining area is considered to be oxidation to form reduced sulphates. The sulphates percolates downward with meteoric water and combine with barium bearing brines like $BaCL_2$, Ba F_2, and Ba CO_3. During the migration of ascending magmatic emanations and hydrothermal solution barium bearing brins combine with the sulphate to precipitate the barytess. The precipitating mineralizing solution was travelled upward through the major NNE-SSW Trending fault between Aravalli and Delhi and deposited along cross joint at places along bedding foliation planes.

Key words: Specimens, mineral, igneous rocks, mobilized.

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INTRODUCTION

Barytess, or **barite**, ($BaSO_4$) is a mineral consisting of barium sulfate. The *barytes group* consists of barytes, celestine, anglesite and anhydrite. Barytes itself is generally white or colorless, and is the main source of barium. Barytes and celestine form a solid solution (Ba,Sr)SO_4.

Barytes that is used as an aggregate in a "heavy"cement is crushed and screened to a uniform size. Most barytes is ground to a small, uniform size before it is used as a filler or extender, an addition to industrial products. Some 77% worldwide is used as a weighting agent for drilling fluids in oil and gas exploration to suppress high formation pressures and prevent blowouts. As a well is drilled, the bit passes through various formations, each with different characteristics. The deeper the hole, the more barite is needed as a percentage of the total mud mix. An additional benefit of barite is that it is non-magnetic and thus does not interfere with magnetic measurements taken in the borehole, either during logging-while-drilling or in separate drill hole logging.

GENETIC MODEL

Barytes occurs in a large number of depositional environments, and is deposited through a large number of processes including biogenic, hydrothermal, and evaporation, among others.[1] Barytes commonly occurs in lead-zinc veins in limestones, in hot spring deposits, and with hematite ore. It is often associated with the minerals anglesite and celestine. It has also been identified in meteorites.

Sedimentary exhalative deposits are the most important source of lead, zinc and barites and that the ore minerals were deposited in a marine second-order basin environment, related to discharge of metal-bearing brines into the seawater. This is distinct from other Pb-Zn-Ag and other deposits which are more intimately associated with intrusive or metamorphic processes or which are trapped within a rock matrix and are not exhalative.

The process of ore genesis of sedimentary exhalative mineralization is varied, depending on the type of ore which is deposited may be sourced from magmatic fluids from subseafloor magma chambers and hydrothermal fluids generated by the heat of a magma chamber intruding into saturated sediments. This scenario is relevant to mid-ocean ridge environments and island arc volcanic chains where black smokers are formed by discharging hydrothermal fluids.

- *Transport* of these brines follows stratigraphic reservoir pathways toward faults, which isolate the buried stratigraphy into recognisable sedimentary basins. The brines percolate up the basin bounding faults and are released into the overlying oceanic water.

- *Trap* sites are lower or depressed areas of the ocean topography where the heavy, hot brines flow and mix with cooler sea water, causing the dissolved metal and sulfur in the brine to precipitate from solution as a solid metal sulfide ore, deposited as layers of sulfide sediment.

Upon mixing of the ore fluids with the seawater, dispersed across the seafloor, the ore constituents and gangue are precipitated onto the seafloor to form an orebody and mineralization halo which are congruent with the underlying stratigraphy and are generally fine grained, finely laminated and can be recognized as chemically deposited from solution.

Arkose-hosted sedimentary exhalative deposits are known in some cases, associated with arkosic strata adjacent to faults which feed heavy brines into the porous sands, filling the matrix with sulfides, or deposited within a predominantly arkosic layer as a distinct chemical sediment layer usually associated with a shale interbed or at the lowermost levels of a shale formation directly overlying arkosic sands (for example, copper deposits near Maun, Botswana).

ORE GENESIS OF RAJGARH AREA:

Barytess deposites of Alwar district, Rajasthan occur in two distinct belts i.e. Rajgarh and Alwar belt. The barytess producing mines are mainly located in Rajgarh belt. The deposits of Rajgarh area belong to the Proterozoic supra crustal of Delhi supergroup laying uncomformably over the Archaen granite of Aravali Supergroup. The stratigraphic sequence strats from Aravalli system overlain by Pre Delhi Formation. The sequence of Delhi Supergroup starts with basal conglomerates, which is arkosic at places. The entire sequence shows a facies change from arenaceous member in the lower portion to calcareous in the middle and argillaceous in the upper portion.

Major structure in the area are NE-plunging syncline in Guarah Gujar mine area and N-plunging anticline in north of Rajgarh and Reni anticline. Beside the prominent faults are ; (1) The Rajgarh fault, (2) Sure fault and (3) Fault running to the S.E. of Guarah Gujar.

Barytess of Rajgarh area occurs s veins, veinlets and lenticular form in quartzite interbedded with phyllite, quartz-sericite-schist intrbedded with quartzite. The different types of fissures veins of byrites viz: simple, chambered, dilation or lenticular, sheeted and linked and en'echelon veins, formed by the cavity filling process of hydrothermal solution is one of the most important feature.

SOURCES OF BARIUM

In Rajgarh belt the barium is thought to be derived from magmatic and volcanic emanations. The metavolcanics present in the area, represented by massive amphibolites and amphibolites schist. Further more one of the source of barium was the meteoric water circulating downward which extracted barium from alkali felspars of granite of Aravalli system and felspathic and massive quartzite of Alwar series, which is similar to that of barites deposites of east Missouri(Leach 1981) and Iglesiente- Sulsis Italy (Cortecci et.al.1989).

SOURCES OF SULPHUR

The sulphur required for the precipitation of barites in the Rajgarh area thought to have been derived from the sulphides of the area. Besides, it might have been derived from Kho-Dariba Copper deposites area which is near to the barites deposites of the area, indicated by the following equation;-

$FeS_2 + 1½O_2$ Normal temp. FeO + SO_2 + S

----------→ Oxidised Reduced

The additional source of sulphure could be envisaged from chalcopyrite also, which is represented by the following equations

$2CuFeS_2 + CO_2 + H_2O + 2O_2$ ----------→ $Cu_2(CO_3)(OH)_2 + 2FeO + 4S$

Malachite Reduced

The presence of carbonaceous phyllite in the are suggested that the CO_2 was derived from the organic matter which is also responsible for the formation of malachite. Besides, the appreciable quantity of sulphure has been provided by leeching of granite of the Rajgarh belt, similar to that as suggested by Cortecci et.al.(1989) for Iglesientesulsis barites of Italy.

MIGRATION OF MINERALIZING FLUIDS:

The large amount of base metals can be transported and deposited by chemical solutions was similar to that which was required for the transport of large amount of barium and depositing as barites (Blount, 1977). Accordingly in Rajgarh area, the various gases like HCL, HF and CO_2 were available due to volcanic and magmatic emanations which combine with barium in anhydrous phase to form various brines like $BaCL_2$, BaF_2 and $BaCO_3$as barium has many affinities with highly electronegative elements like Cl, Br, CO_2 etc. accordingly barium is easily transported in the form of barium bearing brines.

PRECIPITATION OF BARYTESS:

The barites of Rajgarh area has been precipitated due to the non-equilibrium oxidation of reduced sulphure from sulphide ores in the country rocks. The oxidation of sulphur may also take place from H_2S or HS carried by brines and oxidation promoted by dissolved oxygen in meteoric water (Ohomoto and Rye, 1979) as shown in reaction:

$HS + 2O_2$ ----------→ $SO_2^{2-} + H^+$

The precipitation of berytes of Rajgarh area can better be explained by chemical model in which a series of oxidation –reduction reactions are involved. Sulphides in country rocks and adjoining area is considered to be oxidation to form reduced sulphate. Pyrite and chalcopyrite get oxidized to form reduced sulphur at normal temp. and aereal conditions which further gets oxidized in to SO_2 and sulphite (SO_3)at some higher temperature, which are soluble in water and H_2SO_3 and H_2SO_4 respectively as shown in the following equation:

$FeS_2+1½O_2$ Normal temp. FeO + SO_2 + S

----------→ Oxidised Reduced

$2CuFeS_2$+ CO_2 + H_2O + $2O_2$ ----------→ $Cu_2(CO_3)(OH)_2$ + 2FeO + 4S

Malachite Reduced

SO_2 + $½O_2$ ----------→ SO_3 (Oxidised Sulphur)

$SO_2 + H_2O$ ----------→H_2SO_3

$SO_3 + H_2O$ ----------→ H_2SO_4

H_2SO_4 further reacts with sulphides to form sulphate under some changed conditions of temperature at some greater depth.

$FeS_2 + H_2SO_4$ ----------→ $FeSO_4$ + H_2S + S (Reduced)

This sulphate percolates downward with meteoric water and combine with barium brine like BaCl2, BaF2 and Ba Co3 which formed due to interaction of barium in hydrous form and various gases like HCl, HF and CO2 which were available from magmatic and volcanic emanations as shown in the following equation:

Ba + 2HCl ----------→ $BaCl_2 + H_2$

Ba + 2HF ----------→ $BaF_2 + H_2$

Ba + $CO_2 + H_2O$ ----------→ $BaCO_2 + H_2$

During the migration of ascending magnetic emanations and hydrothermal solutions the barium bearing brins combine with the sulphate to precipitate the barites as shown in the following reaction:

$BaCl_2$ + $FeSO_4$ ----------→ $BaSO_4$ + $FeCl_2$ (Soluble in water)

BaF_2 + $FeSO_4$ ----------→ $BaSO_4$ + FeF_2 (Soluble in water)

$BaCO_2$ + $FeSO_4$ ----------→ $BaSO_4$ + $FeCO_3$ (Soluble in water)

The precipitated mineralizing solution was travelled upward through the major NNE-SSW trending fault between Aravalli and Delhi's and deposited along cross joints and at places along bedding foliation planes. It shows structural control of mineralization of Rajgarh area.

CONCLUSION:

On the basis of mode of occurrence, texture and structure exhibited by the barites mineralization of the area, it is therefore concluded that the Rajgarh barites deposits formed at low temperature and pressure (telethermal) in which the mineralizating solution was controlled structurally and deposited at the open spaces as cavity filling during the last phase of hydrothermal activities

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