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Geochemical Aspects of host rocks in Potin Area of Subansiri District, Arunachal Pradesh (NE India)

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Abstract: The present study area is located in and Subansiri district of North Eastern state Arunachal Pradesh. Sulphide ore minerals were found in the study area in garnetiferous quartz- biotite- schist belonging to the Bomdila Group and the process was under structural control. The sulphides mainly consist of chalcopyrite-pyrite-pyrhotite and sphalerite. Geochemically

Major, trace and trace elements abundant is significantly noted in the host rock of the study area. The host rock is silica poor (less than 60% SiO2). Trace elements like appear to have high Cr, V, Ba and Rb and low Sr. The host rocks of the area are LREE (La, Ce, Nd) show enrichment and relatively flate HREE with positive Eu anomaly. The host rock possesses an oceanic deep seated hydrothermal character and sediments accumulated in an active continental margin and/or island arc represent melt from upper mantle.

Keywords: Potin Area, Subansiri district, Arunachal Pradesh, sulphide ore, Major, trace, REE, upper mantle

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1. Introduction

The present area is situated in the district of Lower Subansiri district, Arunachal Pradesh (NE India) (Fig.1). Sulphide mineralization in the area was first noted by Laskar (1959), following which Roy Choudhary (1961), Rao and Dias (1963)

.Mineralization in the area was both structurally and lithologically controlled. Structural elements include schistosity plane striking NE-SW dipping about 35O towards SE direction and shear planes developed often making low angle with the schistosity.

The host rock is strictly confine to the peliticschists or garnetiferrous quartz-biotite schist belonging to the Palaeoproterozoic Potin Formation of Bomdila Group. Mineralization in the area was dominated by chalcopyrite, pyrite, pyrhotite, sphalerite with occasional occurrence of magnetite and arsenopyrite.

The present paper deals with the abundance and interpretation of geochemical elements in the host rock of Potin area of Subansiri district of Arunachal Pradesh.

Fig.1. Location map of the study area

2. Regional Geology of the area

The area under study comprising mainly of Lesser Himalayan rocks locally known as 'Potin Formation' which is equivalent of Khetabari Formation of Bomdila Group (Gopendra Kumar, 1997). The lithology, structure and tectonic of the Khetabari formations are briefly enumerated briefly in light of the study of early workers in the following pages. The stratigraphic sequence as described by a group of geologist of the Geological Survey of India is shown in Table. 1 as follows.

Table 1. Stratigraphic sequence of the area according Kakoti et. al., (1970)

Hanging Wall (granite and gneisses)

POTIN FORMATION	Bitite-muscovite-quartz schist, chlorite-muscovite-garnet magnetite schist, Chalcopyrite mineralisation, Biotite-muscovite-garnet schist with intervening quartzite-pyrrhotite mineralisation
	Amphibole-chlorite-biotite-garnet schist, Biotite-muscovite-garnet schist, Chlorite-biotite-muscovite-staurolite-garnet schist, Chlorite-schist (with special occasional sericite-muscovite)-pyrite and pyrrhotite mineralisation. Biotite-muscovite-quartz schist

Foot Wall (granite and gneisses)

3. Geological Setting

The exposed lithology in and around Potin (Fig.2) belongs to the crystallines of the lesser Himalaya and mainly consists of quartz mica schist and biotite gneiss resting over a narrow patch of Gondwana on a hidden thrust. The general foliation trend is ENE-WSW with moderate dip of 35 towards the SE direction. The tight isoclinal F1 folds have highly appressed limbs and thick hinges with axial plane dipping to the north-west. These folds are recline type. The second generation F2 folds have a coaxial relationship with the F1 folds and could be seen on cross section with fold axis plunging to NNW direction. The axial plane of F2 folds maintain near orthogonal relationship with F1 folds. The thrust parallel drag and thrust imbrication are also observed at places facilitating avenues for upward movement of mineralizing solutions. Cross fractures indicate a north-south trend and are indicative of southward movement of sequence and accommodation of stress.

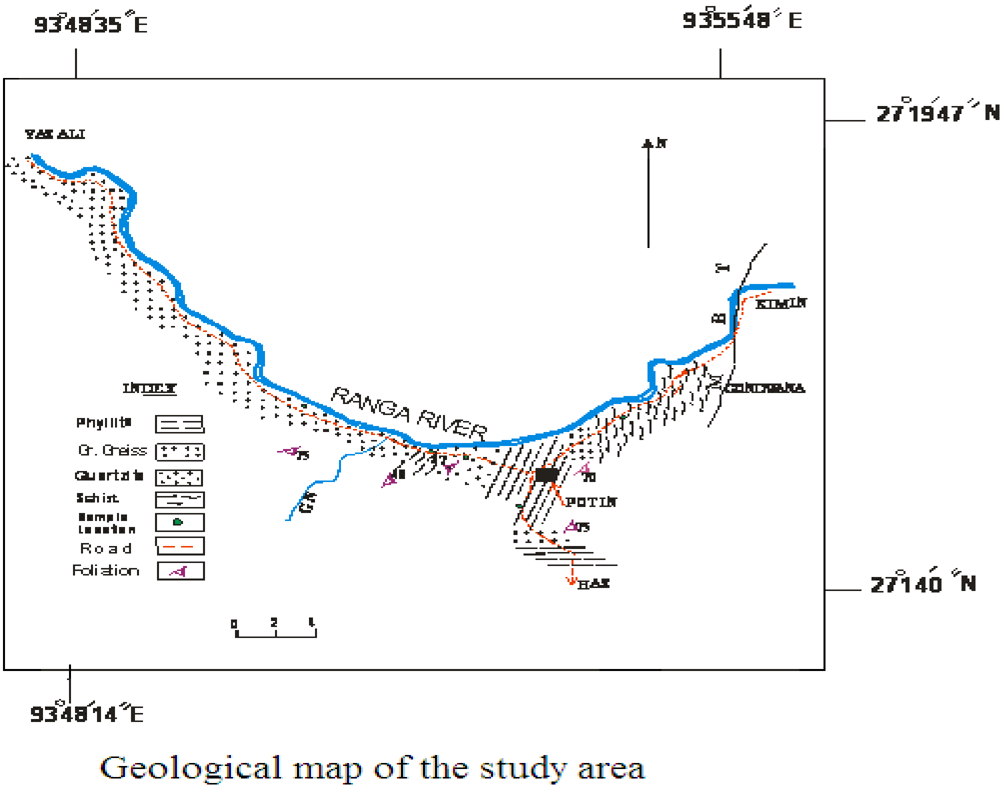

Fig.2 Geological map of the study area

4. Sampling and analytical methods

Twenty host rock samples were drawn from mineralized lithounits. The representative specimens, from different localities, were crushed in agate mortar to 230 mesh sizes. The powdered samples were thoroughly mixed and after coning and quartering, 10gm of each samples for XRF analysis and 1gm of samples for ICP – MS analysis were packaged properly and dispatched to various esteemed National laboratories which allowed making analyses on hiring services basis.

4. Result and discussion

4.1 Petrography of the host rock

The sulphide mineralization was hosted by a NNE-SSE to NE-SW trending sub vertical sheet about 30 meters wide garnetiferrous quartz-biotite schist sandwich between granite gneiss to augen gneiss.

4.2 Garnetiferous–quartz-biotiteschist

The rock was highly sheared, fine to medium grained, dark coloured and shows schistose fabric. Thin section study revealed that the rock consisted mainly of quartz, biotite and garnet as major mineral components. Some common minor minerals included feldspars (both alkali feldspar and plagioclase feldspar) and apatite. Chlorites were observed as secondary minerals (altered product of biotite). Grains were highly sheared and some smaller grains of quartz were found as inclusion in garnet fractures. Ore microscopy revealed chalcopyrite mineralization along with some streaks of pyrhotite. Garnets were characterized by very high almandine contents (72.7% to75.8%)and very low grossular contents with little zonation.The almandine contents showed an increasing order from core to rim in the analyzed samples. Mn contents of the garnets were relatively low (up to 1.4 mole %).

Biotite as primary phase was medium to coarse grained platy in nature and was associated with quartz. Biotite exhibitedpleochroism(X=Y= yellowish brown, Z= pale yellow) and parallel extinction except for some bent crystals, which showed wavy extinction. Chloritization of biotite was also observed.

Although, gneisses, quartzites, phyllites and gneissic rocks occurred in the area, were barren.

4.3 Major element geochemistry

The major oxide of the representative host rock samples of the Potin area are presented in Table No. 2. Mineralised fine porphyritic metapelites are silica poor (majority of samples contain <60% SiO_2), Al_2O_3 enriched is (>10%); K_2O is 0.77% to 8.74%; K_2O/ Al_2O_3 is 0.06% to 0.36% indicating significantly low alkali feldspar content in parent rock; CaO is erratic; higher Fe_2O_3 (Total) content of the rock; P_2O_5 ranges between 0.03 and 0.06 wt %; In Harker's variation diagrams of selected major elements, the Potin samples exhibit a wide range of SiO_2 and negative trends of TiO_2, Al_2O_3, Fe_2O_3, P_2O_5, MgO, CaO but K_2O are mostly scattered (Fig.3). In these samples higher concentration of K_2O than Na_2O which is related to modal content of plagioclase and K-feldspar. Higher molar Al_2O_3/CaO+Na_2O+K_2O(A/CNK=(1.08-1.78) of Potin samples supports the peraluminous nature. The A-CN-K plot is a useful tool to examine provenance and weathering histories. To achieve the same objective the CIA values of Potin samples were plotted in the Al_2O_3-(CaO+Na_2O)-K_2O triangular diagram (Fig. 4). This figure suggest that the metapelitic rocks of the study area might be gabbro or basaltic in composition. Contrary to the general belief, this mineralised metapelites were emplaced in active continental margin and evolved in back arc setting-felsic plutonic detritus (Maynard, 1982).

4.4 Trace Element Geochemistry

The analytical trace element data of the study area is shown in Table No. 3. It is apparent from the trace element data the host rocks are characterized based on the limited information available on trace element contents, it appears that the present metapelites are higher in Cr(67.63-395.339) ppm, V(35.009-99.061)ppm, Ba(144.499 -643.859)ppm and Rb(112.0318-117.031)ppm and lower in Sr. (27.177 -63.323)ppm. In terms of trace elements, the present garnet bearing metapelites appear to have high Cr, V, Ba and Rb and low Sr.

Garnetiferous metapelites are characterised by high HFS elements e.g. Zr, Nb etc. REE, Y; strongly enriched in Cr, Ni, and V; Zr content varies between 2.596 – 27.136 ppm; Nb content ranges from 2.637-16.064 ppm.

4.5 The LILE

Ba varies between 33.655 – 643.859 ppm which is relatively high; enriched Rb content (average is 115.75ppm); low values of Sr (25.80 – 199.8 ppm with the mean of 76.7 ppm); La (17.947 – 18.578 ppm) and Ce (30.464 – 40.758 ppm); the Ga content of the rocks (12.978 – 26.314ppm); Cu content is abnormally high (20.136ppm -631.247ppm).

Trace element data of these metapelites show enrichment in high field strength elements (HFSE) such as Cr, Rb, Ni and V.

In Harkers's variation diagrams Ba, Sr with SiO2 in Potin samples show negative correlation (Fig. 5.4).

Tectonic discrimination diagram (Th/Ta-Ta/Yb and Th/Ta-Yb) suggests that the metapellitic rocks were emplaced in active continental margin (Fig. 6).

4.6 REE distribution

The analytical REE data of the samples area is shown in Table No. 4.

The host rocks of the area are LREE (La, Ce, Nd) show enrichment and relatively flate HREE with positive Eu anomaly. Positive Eu anomaly supports the primary mantle derived oceanic hydrothermal activity (Nakamura, 1974) (Fig. 7).

(La/Yb)n of the metapelites are vary from 0.24 to 41.21, averaging 22.79 indicating high fractionation. HREE-fractionated pattern suggest that garnet could be a residual phase during the formation of the source rocks.

Table No. 2

Major oxides composition of host rock from the study area

Sample	PS M1	PS M2	PS M3	PS M4	PS M5	PS M6	PS M7	PS M8	PS M9	PS M10
SiO_2	64.11	59.56	52.68	44.87	58.35	56.67	68.85	58.35	56.67	68.85
TiO_2	0.26	0.9	0.79	0.85	0.9	0.64	0.57	0.9	0.64	0.57
Al_2O_3	17.01	15.56	12.56	12.87	25.61	12.44	12.34	25.61	12.44	12.34
Fe_2O_3	10.09	7.37	21.09	24.85	5.52	19.9	6.99	5.52	19.9	6.99
MnO	0.09	0.1	0.33	0.31	0.03	0.38	0.08	0.03	0.38	0.08
MgO	3.11	3.29	6.72	5.57	3.09	5.44	0.59	3.09	5.44	0.59
Na_2O	2.05	6.6	0.11	0.72	1.19	0.44	0.22	1.19	0.44	0.22
K_2O	1.4	2.35	4.6	0.77	5.33	3.54	8.74	5.33	3.54	8.74
P_2O_5	0.03	0.08	0.04	0.29	0.06	0.24	0.06	0.06	0.24	0.06
CaO	0.54	0.87	1.07	0.95	0.13	0.55	0.42	0.13	0.55	0.42
Total	98.69	96.68	99.99	96.22	100.21	100.24	98.86	100.21	100.24	98.86

Table No. 3

Trace element analytical data on host rock from the study area

Sample	PS M1	PS M2	PS M3	PS M4	PS M5	PS M6	PS M7	PS M8	PS M9	PS M10
Sc	13.407	13.367	12.037	12.237	9.962	13.407	13.547	13.037	20.598	10.962
V	92.725	91.921	99.061	98.061	63.688	92.725	90.921	96.061	35.009	64.688
Cr	67.63	69.287	59.486	60.486	395.339	67.63	68.287	60.486	73.132	95.339
Co	5.612	5.673	5.38	6.38	30.319	5.612	6.673	6.38	33.885	32.319
Ni	24.756	24.686	19.641	22.641	20.989	24.756	22.686	21.641	32.078	21.989
Cu	20.136	20.496	21.701	20.701	632.061	20.136	21.496	23.701	5.038	32.061
Zn	39.409	40.015	57.495	50.495	61.481	39.409	41.015	47.495	69.626	51.481
Ga	26.259	26.315	25.967	26.967	13.384	26.259	25.315	26.967	18.535	16.384
Rb	117.318	117.031	112.181	114.181	115.495	117.318	115.031	113.181	5.289	114.495
Sr	63.323	63.349	38.077	50.077	27.177	63.323	65.349	58.077	23.756	26.177
Y	5.985	5.922	5.532	6.532	18.966	5.985	6.922	4.532	17.039	19.966
Zr	5.07	27.136	4.98	5.98	2.596	5.07	27.136	21.98	8.471	8.596
Nb	15.465	15.798	16.064	15.064	13.244	15.465	12.798	13.064	2.637	12.244

Cs	1.923	1.877	1.909	1.709	2.727	1.923	1.577	1.609	0.143	2.767
Ba	206.387	205.825	144.499	145.499	643.859	206.387	204.825	143.499	132.655	643.859
Hf	0.176	0.206	0.106	0.110	0.078	0.176	0.106	0.126	0.818	0.578
Ta	1.414	1.422	1.3	1.5	2.944	1.414	1.622	1.41	0.156	12.94
Pb	10.932	11.049	10.882	11.882	4.57	10.932	11.149	11.882	11.901	10.57
Th	15.966	16.089	13.795	12.795	10.509	15.966	14.089	14.795	11.384	11.509
U	1.549	1.487	1.126	1.226	1.798	1.549	1.687	1.526	1.268	1.698

Table No. 4

REE analytical data on host rock from the study area

Sample	**PS M1**	**PS M2**	**PS M3**	**PS M4**	**PS M5**	**PS M6**	**PS M7**	**PS M8**	**PS M9**	**PS M10**
La	18.436	18.577	20.277	21.245	27.71	18.436	18.577	20.277	5.603	27.71
Ce	30.464	30.738	31.657	32.901	40.758	30.464	30.738	31.657	10.901	40.758
Pr	3.568	3.64	3.979	2.638	3.614	3.568	3.64	3.979	1.638	3.614
Nd	13.272	13.444	14.548	17.818	16.7	13.272	13.444	14.548	7.818	16.7
Sm	2.883	2.881	3.187	3.537	3.314	2.883	2.881	3.187	3.537	3.314
Eu	1.562	1.564	1.224	1.424	2.578	1.562	1.564	1.224	0.688	2.578
Gd	2.479	2.386	2.54	2.591	3.928	2.479	2.386	2.54	7.591	3.928
Tb	0.366	0.387	0.37	0.354	0.616	0.366	0.387	0.37	2.739	0.616
Dy	1.647	1.686	1.615	1.123	3.225	1.647	1.686	1.615	28.674	3.225
Ho	0.224	0.243	0.228	0.234	0.649	0.224	0.243	0.228	3.914	0.649
Er	0.523	0.555	0.499	0.532	2.133	0.523	0.555	0.499	13.341	2.133
Tm	0.065	0.072	0.052	0.064	0.329	0.065	0.072	0.052	1.729	0.329
Yb	0.401	0.403	0.328	0.524	1.656	0.401	0.403	0.328	15.695	1.656
Lu	0.049	0.049	0.043	0.045	0.225	0.049	0.049	0.043	2.059	0.225
Eu/ Eu*	1.80	1.83	1.32	1.44	1.60	2.74	2.16	2.33	1.06	1.65
(La/ Yb)n	30.65	30.73	37.76	38.74	37.64	38.51	38.93	41.21	38.75	37.65
∑ REE										

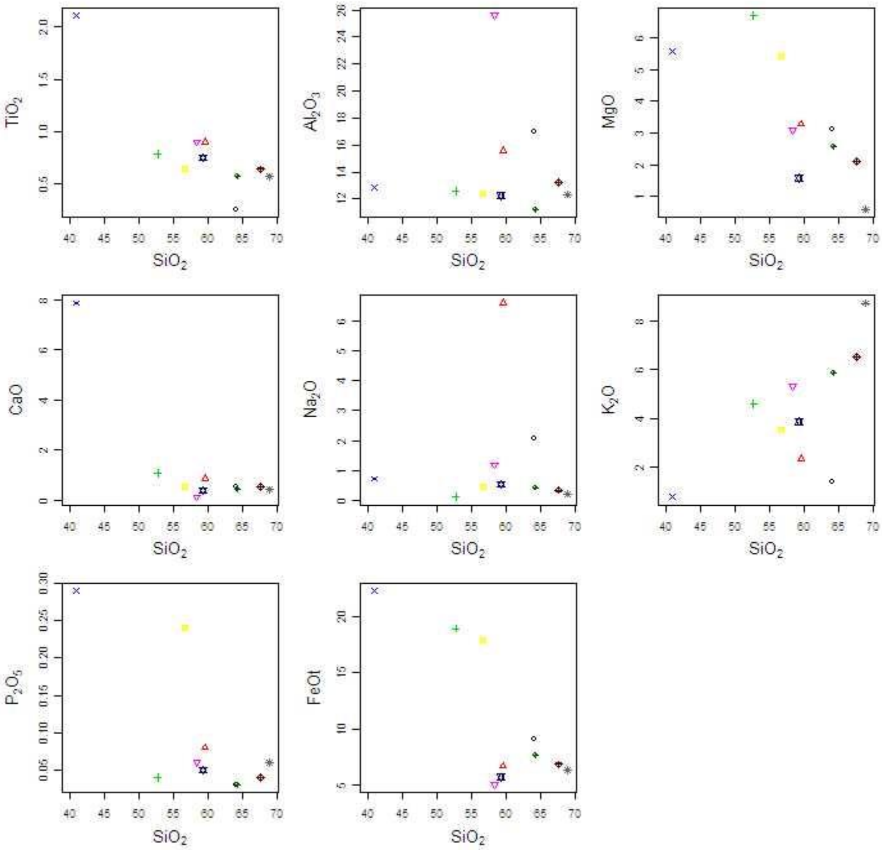

Fig. 3 Variation diagram of major oxides

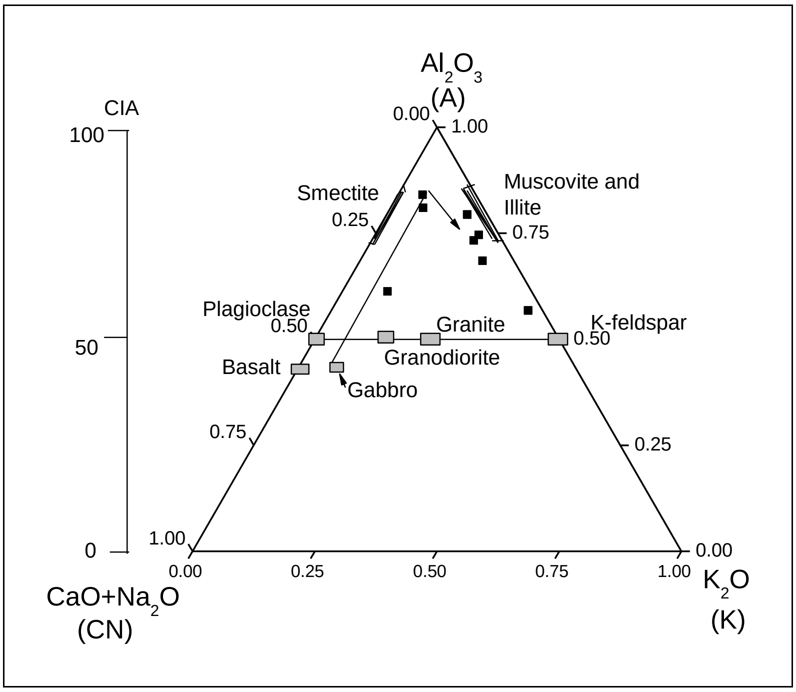

Fig. 4 (Na2O+CaO)-Al2O3-K2O diagram of Nesbit and Young (1984, 1989)

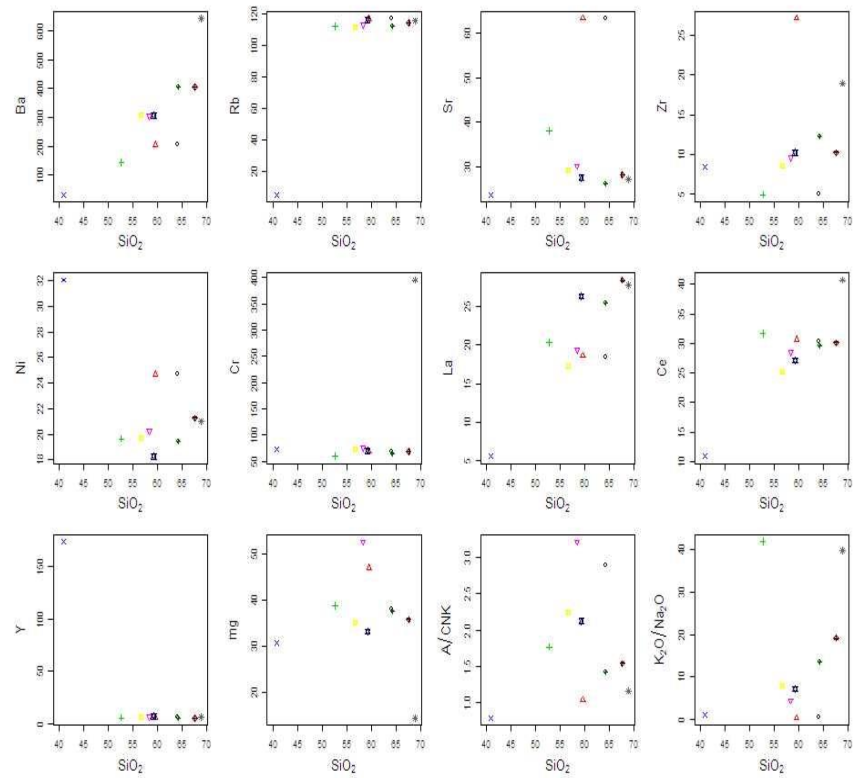

Fig. 5 Variation diagram of trace elements

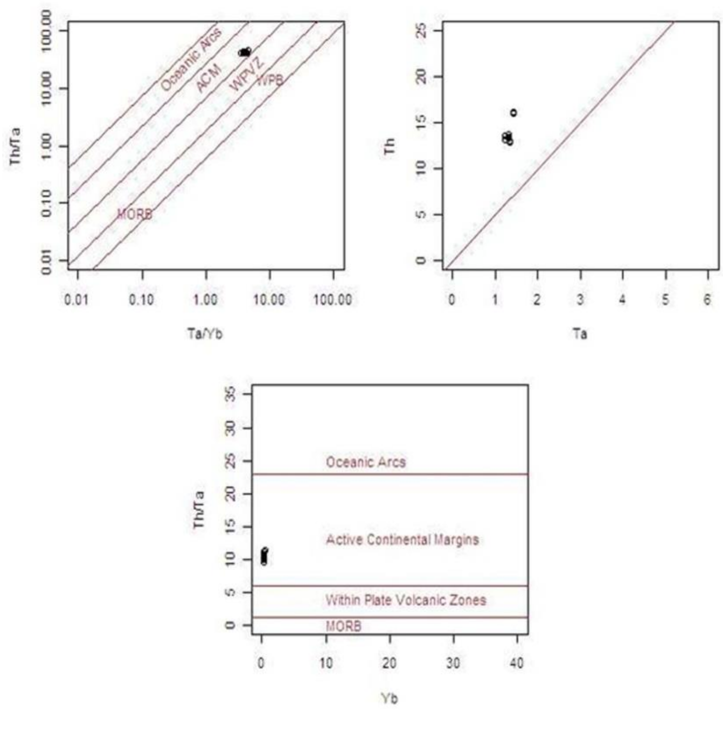

Fig. 6 Tectonic discrimination diagrams

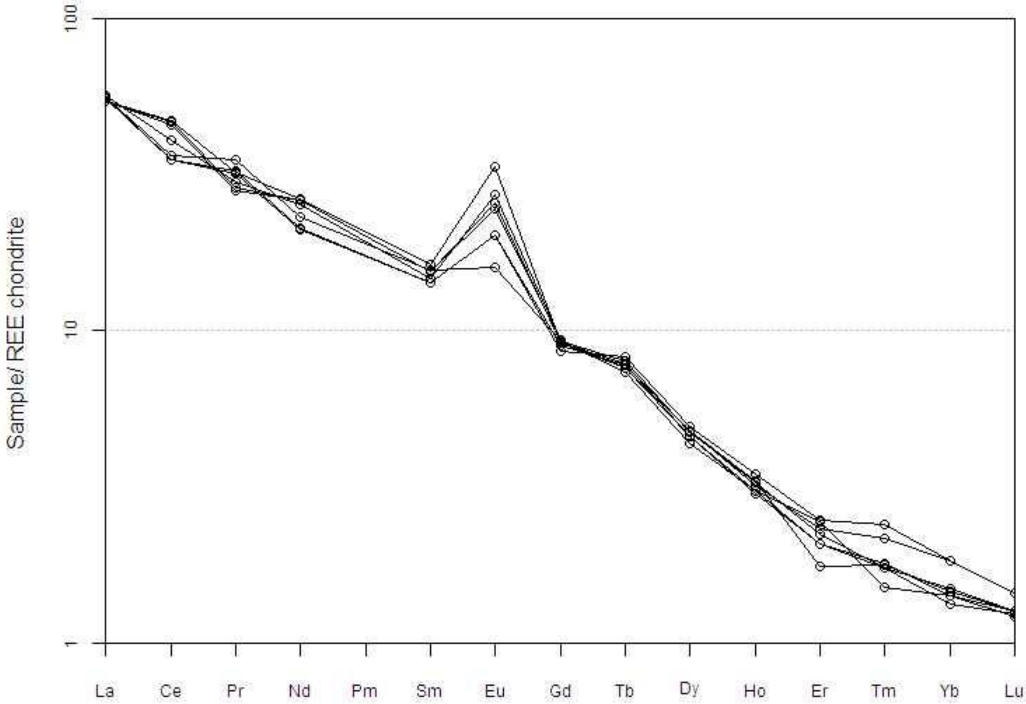

Fig 7 Chondrite-normalised plot of REE (normalized after Nakamura, 1974)

5. Conclusion

From the overall study, the following conclusions were derived

■ Mineralization in Potin area was in garnetiferrous quartz- biotite-schist belonging to Bomdila Group of Potin Formation (equivalent to Khetabari formation).

■ Consistent occurrences of sulphide ores with metasedimentary rocks in Potin and nearby locations support a close relationship with sedimentary environment.

■ The dominant host rock of ore minerals is garnetiferrous- quartz-biotite schist

■ The major, trace and REE compositions of the host rocks offer clues on several important aspects such as trend of original basin configuration, tectonic environment and metamorphic signature i.e. selective depletion of the metamorphic rocks during almandine-amphibolite facies.

■ The host rock of ore mineralization was metamorphosed under almandine-amphibolite facies conditions

■ The deformation and metamorphism of the country rocks might have been taken place during the Tertiary Himalayan Orogeny

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