Indian Streams Research Journal ORIGINAL ARTICLE ISSN:-2230-7850

GEOCHEMICAL CONSTRAINTS OF ULTRAMAFIC ROCKS OF BARA-IRGA AREAS IN NORTH PURULIYA SHEAR ZONE WEST BENGAL

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Abstract:-The present study includes documentation of geochemical characters of ultramafic rocks ranging in composition from pyroxenite to hornblendite and associated with mafic rocks along the North Puruliya Shear Zone. The geochemical signatures show a significant variation in major and trace element concentration and the magma type is tholeiitic in nature being deficient in potash. The tectonic setting discrimination diagrams together geochemical characterization suggest volcanic arc tectonic settings.

Keywords: Geochemical constraints , Ultramafic rocks , element concentration .

INTRODUCTION:

In the northern part of Puruliya district of West Bengal number of occurrences of ultramafic are recorded aligned parallel to a megalineament known as North Puruliya Shear Zone (NPSZ). These rocks are intruded within the high grade Proterozoic rocks of Chotanagpur Gneissic Terrain , CGT (Mahadevan, 1992; Dasgupta et al. 2000; Mandal and Ray, 2009). The study area (Fig.1) is composed mainly of granitoid gneisses both porphyritic and nonporphyritic which contain scattered lenses and patches of quartzites, amphibolites and khondalites of mostly amphibolites facies metamorphism in the western part and basic granulite, metanorite and calc-silicate rocks of mostly granulite facies metamorphism in the eastern part. One regional trend of the metamorphites and granitoid gneisses is generally E-W to ENE-WSW and the dip is generally towards north (Mazumder, 1988; Sarkar 1988, Baidya et al. 1989). Precambrian rocks of area have undergone three phases of folding (Baidya et al. 1987). The first two deformations F1 and F2 had produced E-W axial planes. F1 is not well preserved whereas F2 is dominant and well preserved. The last phase of deformation in the area is represented by development of a set of Shear Zones. The most prominent of these is the southern most one and is known as North Puruliya Shear Zone (NPSZ) which has overall trend of E-W. The ultramafic rocks are confined to the eastern part of NPSZ. The ultramafic rocks of the area are represented by pyroxenites having olivine websterite and Lherzolite in composition. These rocks occur as thin lenses and bands whereas some outcrops shows moderate thickness. Emplaced along reactivated lineaments, Shear zones and deep crustal fractures. In the study area the shearing in intense and has affected all the rock types.

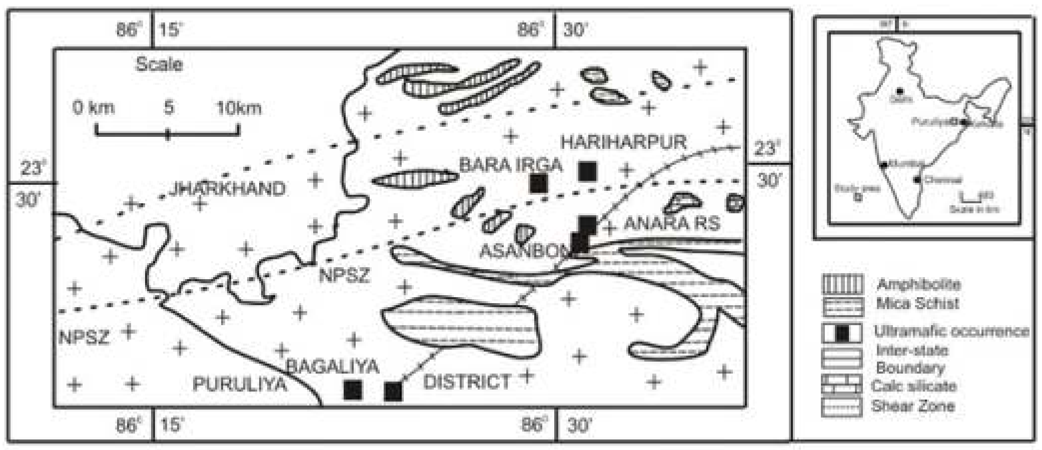

Fig. 1

In t , on the either sides of Gondwana basin and in NPSZ (Ghose 1983, 1992; Ghose and Chatterjee 2008, Bhattacharya et al. 2010; Prasad and Bhattacharya 2012; 2013). The present paper aims to focus the geochemical characteristics of pyroxenites occurring in the area and to suggest possible tectonic environment of their emplacement.

PETROGRAPHY

Pyroxenite is the dominant lithology in the study area. They are massive coarse grained and dark grey in colour. Microscopically they exhibit characteristic olivine, plagioclase, amphibole, phlogopite, magnetite to olivine websterite (Table 1).

They show evidence of shearing and retrogressive metamorphism. Medium to coarse grained ultramafic rocks range in composition from pyroxenites (viz olivine websterite, websterite, plagioclase websterite) to hornblendite showing cumulus texture. They are composed of clinopyroxene (diopside-salite), orthopyroxene (hyperthene-enstatite-bronzite), olivine and sporadic plagioclase, phlogopite and opaques. Coarse, equant and subhedral crystals of diopside predominate. Diopside plates contain exsolution lamellae of grey or dark grey stringes of bastite and irregular patches of phlogopite along the prismatic cleavage of the pyroxene. Salites occur as small grains of granulitic aggregate representing original diopside. Hypersthene occurs as coarse, subhedral and stout prismatic crystal. Sometimes hypersthenes and enstatite occur as corona around olivine . Olivine occurs as coarse, equant, subhedral grains in the interspaces of pyroxenes and are partially or completely enclosed in both orthopyroxene and clinopyroxene. Amphiboles are of two types: (i) The predominant type is greenish brown or brownish green hornblende and (ii) greenish tremolite actinolite with fibrous appearance. Plagioclase occurs as medium to coarse subhedral grains interstitial to cumulus olivine, pyroxene and amphibole. Phlogopite occurs as irregular medium sized grain along the contact of olivine and pyroxene and also within pyroxene. It replaces both olivine and pyroxene. Spinel is a minor accessory and occurs as fine five irregular specks associated with ferromagnesiam minerals.

Table 1. Modal composition of ultramafic rocks (volume %)

Sl.No	1	2	3	4	5
Clinopyroxene	32	47	43	15	24
Orthopyroxene	22	39	42	19	18
Plagioclase	10	4	2	8	16
Opaque	2	-	2	2	-
Quartz	-	-	-	-	-
Olivine	8	9	8	38	34
Hornblende	22	2	3	5	
Biotite	6	9		13	8
	100	100	100	100	100
	Olivine Websterite	Olivine Websterite	Olivine Websterite	Lherzolite	Lherzolite

GEOCHEMISTRY

Ten representative pyroxenite samples were analysed for bulk rock chemistry at National Geophysical Research Institute (NGRI), Hyderabad. Major elements were determined by X-ray fluorescene Spectrometry (XRF) using Philips MAGI X PRO Model 2440. Trace and REE were analysed by Inductive Coupled Plasma Mass Spectroscopy (ICP-MS). The result of chemical analyses are presented in Table 2 and Table 3.

Sample no.	SB6	SB7	SB8	SB9	SB10	SB15	SB16	SB21	SB30	SB31
Major Oxides (wt%)										
SiO_2	43.85	44.44	43.06	45.7	44.87	41.25	44.35	42.06	43.5	45.52
MgO	24.2	21.98	24.33	19.55	21.87	25.55	22.08	25.1	23.57	20.06
Na_2O	1.12	0.88	1.25	0.44	0.76	1.3	0.98	1.28	1.06	0.52
K2O	1	0.92	1.02	0.51	0.88	1.1	0.96	1.1	0.99	0.05
Fe_2O_3	10.32	9.66	10.55	7.23	9.32	11.02	9.98	10.88	10.15	8
CaO	9.68	7.72	10.52	5.78	7.02	11.08	8.78	10.76	9.05	6.05
Al_2O_3	7.58	6.88	8.23	4.82	6.2	8.5	7.02	8.4	7.23	5.02
TiO_2	0.72	0.78	0.72	0.98	0.84	0.6	0.73	0.64	0.73	0.9
P_2O_5	0.13	0.06	0.17	0.04	0.05	0.22	0.07	0.2	0.13	0.04
Mg#	70.1042	69.46	69.75	73	70.11	69.86	68.87	69.76	69.89	71.48

Sc	21	30	18	42	33	15	25	17	22	39
V	183	228	152	288	237	125	215	137	198	280
Cr	1351	1855	1223	2915	2022	1190	1605	1205	1442	2710
Co	106	97	110	82	95	120	98	112	101	90
Ni	608	578	720	488	558	780	600	760	602	505
Cu	118	83	121	42	67	130	96	125	101	45
Zn	96	106	108	50	27	120	110	112	105	56
Rb	29	17	33	1	10	40	25	38	27	2
Sr	113	76	228	16	56	350	87	303	92	20
Y	17	16	18	12	15	20	16	19	16	14
Zr	87	58	93	36	61	101	74	97	80	42
Nb	1.65	1.11	1.88	0.48	0.89	2.01	1.23	1.96	1.47	0.66
Cs	1.01	0.88	1.13	0.1	0.65	1.2	0.97	1.2	0.99	0.12
Ba	467	303	553	48	205	650	315	623	358	42

Table 3. Rare Earth Element composition of ultramafic rocks of Anara-Asanboni areas in NPSZ, West Bengal

Sample no.	SB6	SB7	SB8	SB9	SB10	SB15	SB16	SB21	SB30	SB31
La	15.25	9.2	27.8	4.8	78	35.5	10.25	30.2	12.75	5.5
Ce	51.5	30.78	67.3	10.7	22.8	70.2	42.82	68.5	50.5	11.5
Pr	7.22	5.2	8.01	2	4.25	8.2	5.81	8.1	6.68	2.01
Nd	22.56	13.78	32.01	7.2	11.22	35.52	15.81	33.15	17.22	8.52
Sm	7.21	5.5	8.01	1.9	4.5	8.21	6.21	8.15	7.01	2.6
Eu	1.57	1.3	1.76	0.89	1.2	1.82	1.43	1.78	1.49	0.95
Gd	6.1	5.1	6.66	2.25	4.05	7.05	5.22	6.93	5.78	2.99
Tb	0.81	0.6	0.98	0.53	0.57	1.01	0.62	1	0.73	0.42
Dy	2.42	2.3	2.47	2.27	2.3	2.52	2.37	2.5	2.4	2.22
Ho	0.48	0.46	0.49	0.45	0.47	0.49	0.46	0.48	0.46	0.48
Er	1.44	1.44	1.46	1.28	1.38	1.48	1.42	1.46	1.41	1.32
Tm	0.21	0.21	0.22	0.18	0.21	0.23	0.22	0.22	0.22	0.21
Yb	1.32	1.25	1.47	0.99	1.2	1.52	1.25	1.48	1.29	1.08
Lu	0.22	0.16	0.23	0.12	0.18	0.23	0.15	0.23	0.17	0.16
Hf	1.78	1.58	1.88	1.01	1.52	2.22	1.63	2.12	1.72	1.3
Ta	0.11	0.11	0.08	0.1	0.1	0.09	0.1	0.08	0.11	0.1
Pb	4.87	4.6	5.1	3.78	4.6	5.5	4.67	5.3	4.73	4.38
Th	0.92	0.7	2.28	0.4	0.61	3.22	0.76	2.31	0.88	0.5
U	0.88	0.73	0.9	0.11	0.67	0.98	0.89	0.9	0.88	0.21
Total REE	118.31	77.28	158.87	35.56	132.33	173.98	94.04	164.18	108.11	39.96

The geochemical signatures of pyroxenites show a significant variation in major and trace elements. The SiO_2 abundance covers a narrow compositional range of 42.06 to 45.52%. The rock shows a high concentration of iron 7.23 to 11.02, MgO 19.55 to 25.55 % and moderate enrichment of TiO_2 (0.6 to 0.98) and depleted alkalies Na2O (0.44 to 1.30) K_2O (0.05 to 1.1). Bulk composition of the whole rock indicate that the magma type is tholeiitic (AFM Fig. 2).

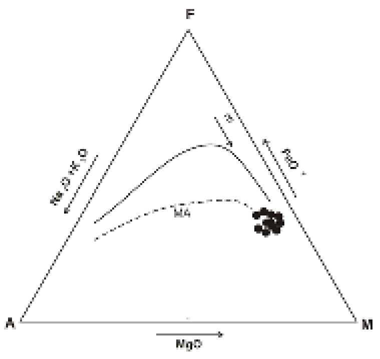

Fig.2

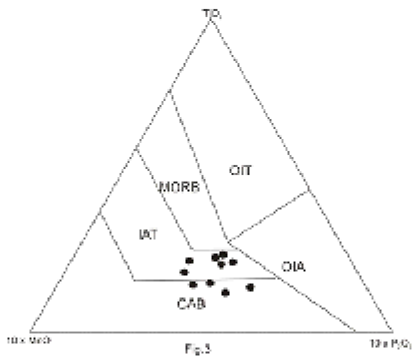

Fig.3

Cr (1190 to 2915 ppm), Co(0.82 to 120 ppm) and Ni(488 to 780 ppm) are high while These pyroxenites are poor in incompatible and HFS elements like Rb, Hf, Ta, Th and U. Sr show remarkable low concentration ranging from (16 to 350 ppm) Total REE value ranges from 35.56 to 173.98 ppm) and show limited LREE fractionated (La/Sm_N=1.32-1.66). The geochemistry of mafic and ultramafic rocks is most commonly used to discriminate tectonic setting. The basaltic rocks are formed in almost every tectonic environment and they are believed to be geochemically sensitive to the changes in plate tectonic frame work.The low LREE and slightly enrichment trend of HREE may be retained to some extent by clinopyroxene or to a greater extent by hornblende. The elements Mn, Ti and P are immobile and insensitive to any alteration. Based on TiO_2, MnO, P_2O_5 triplot (Fig.3 after Mullen 1983). Most of the samples fall within the island arc tholeiite IAT field but some trending towards CAB thus it could be inferred that the tectonic environment of eruption is volcanic are environment of eruption is volcanic are environment. The plot Ti/100 vs V(Fig.4; after Shervais 1982) shows that the studied samples fall in the Arc tholeiitic environment.

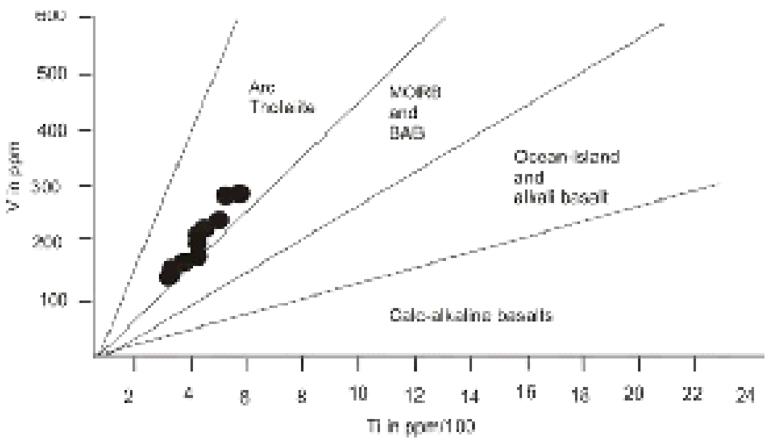

Fig.4

CONCLUSION

Pyroxenites in the area occur as thin lenses and bands in predominantly granite gneiss terrain. Petrographically they exhibit cumulate texture and contain clinopyroxene, orthopyroxene, amphibole, phlogopite, magnetite, illmenite and on the basis of mineral composition they can be aligned as olivine websterite or lherzolite. The major element relations of the studied rock suggest tholeiitic signature. Pyroxenites are poor in incompatible and high field strength (HFS) elements like Rb,Sr,Hf and Ta. The total REE varies in a limited range and exhibits limited REE fractionation in both LREE and HREE various tectonic discrimination diagrams suggest that tholeiitic basalts are produced at destructive plate margins or within plate tholeiite contaminated by continental crust.

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