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TRACE ELEMENT STUDIES OF ULTRAMAFIC ROCKS IN AND AROUND AYYAMPALAYAM AREA, METTUPALAIYAM ULTRAMAFIC COMPLEX, TAMIL NADU WITH SPECIAL REFERENCE TO PGE MINERALIZATION

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Abstract:

Detailed Petrological and Petrochemical studies of the Mettupalaiyam Ultramafic Complex, Ayyampalaiyam Area, Tamil Nadu with special reference to PGE Mineralization. The study area forms a part of southern Indian Peninsula. The Precambrian shield of South India, which forms a coherent crustal segment with continuous geological activity throughout the early Precambrian, offers an excellent ground for the study of Mafic–Ultramafic formations for PGE enrichment. The aforesaid areas are located from west to east and each area being more than 12 km apart falling in the toposheet no 58E/3. The area was mapped on 1:12,500 scale and delineated the Mafic and Ultramafic bands in Ayyampalaiyam Area by early workers (Vijay Kumar & Prabhakar, 2006-09).. Totally 21.25 line km traverses were taken to understand lithological setting and collected groove/chip samples to study with special reference to PGE Mineralization. Ayyampalaiyam Area, Mettupalaiyam Ultramafic Complex forms the southern continuation of the B.R. hills region of southern Karnataka, where Sathyamangalam group of rocks occur within the granulite/ gneiss. The general trend of these rocks is NNE-SSW with dipping towards south in Ayyampalaiyam Area, in the south of Moyar-Bhavani Shear Zone (MBSZ).

Key Words: Trace Element**,** Meta-Pyroxenite, Dunite & Metaigneous

Introduction:

Trace Element Patterns of Metaigneous Suite of Rocks:

The estimated trace of meta anorthosite, metapyroxenite and related suite of rocks of the research area are shown in Table-5. The study of relative concentration of trace element reveals certain systematic distribution pattern between them with 'Eu' positive correlation. The trace element geochemical characteristic of meta-anorthosites, metapyroxenite and related suite of rocks are inferred by plotting them in certain petrochemical diagrams and trace patterns.

Trace Element Analyses Data:

Table 1

S.No		Sample No	Cu ppm	Pb ppm	Zn ppm	Co ppm	Ni ppm	Cd ppm	Ag ppm	Cr ppm
1	Meta-Gabbro	APM-2/12	62	<10	135	38	225	<1	<1	0.3
2	Meta-Pyroxenite	APM-7/12	5	<10	106	44	204	<1	<1	700
3	Meta-Pyroxenite	APM-10/12	37	<10	142	45	264	<1	<1	0.60%
4	Meta-Pyroxenite	APM-12/12	14	<10	53	14	26	<1	<1	240
5	Meta-Pyroxenite	APM-13/12	54	<10	138	51	242	<1	<1	0.18%
6	Meta-Pyroxenite	APM-16/12	27	<10	135	73	505	<1	<1	0.45%
7	Meta-Pyroxenite	APM-17/12	5	<10	90	43	152	<1	<1	420
8	Meta-Pyroxenite	APM-18/12	10	<10	85	47	397	<1	<1	0.70%
9	Meta- Pyroxenite	SLT-12/4	104	<10	45	50	344	<1	<1	136
10	Meta – Pyroxenite	SLT-12/5	82	<10	92	60	112	<1	<1	530
11	Dunite	SLT-M/1	11	<10	31	45	337	<1	<1	0.26%
12	Gabbroic Anorthosite	SLT-12/1	49	<10	29	14	59	<1	<1	104
13	Meta - Pyroxenite	SL-3/1	30	<10	95	55	230	<1	<1	0.57%
14	Meta - Pyroxenite	SL-3/2	9	<10	95	58	377	<1	<1	0.17%
15	Meta Gabbro (S)	SL-3/4	124	<10	86	39	236	<1	<1	0.10%
16	Hb.Bi.Gn	SL-3/5	12	<10	40	14	41	<1	<1	70
17	Meta – Pyroxenite	SL-4/1	4120	<10	82	69	860	<1	<1	760
18	Meta - Pyroxenite	MLN-N/1	84	<10	175	62	329	<1	<1	1.06%
19	Meta - Pyroxenite	MLN-M/1	586	<10	76	68	726	<1	<1	0.39%
20	Gt. Pyroxenite	MLN-1/12	417	<10	96	42	247	<1	<1	280
21	Gt. Pyroxenite	MLN-2/12	152	<10	123	48	194	<1	<1	540
22	Meta. Pyroxenite	MLN-3/12	890	<10	98	54	387	<1	<1	200
23	Gt. Pyroxenite	MLN-4/12	187	<10	100	54	354	<1	<1	240
24	Meta-Pyroxenite fine gr.	MLN-5/12	394	<10	85	45	386	<1	<1	0.41%
25	Pyroxenite within Gt.	MLN-6/12	599	<10	135	54	460	<1	<1	1.92%
26	Cr.Metapyroxenite	MLN-7/12	278	<10	425	70	410	<1	<1	2.62%

S.No		Sample No	Cu ppm	Pb ppm	Zn ppm	Co ppm	Ni ppm	Cd ppm	Ag ppm	Cr ppm
27	Meta-pyroxenite	MLN-8/12	681	<10	108	60	1050	<1	<1	810
28	Gt. Gabbro.	MLN-10/12	223	<10	90	46	131	<1	<1	220

Ayyampalaiyam Area:

Analyses are shown in Table No.5; values are plotted in the multivariation diagram of fig no. 4.6.1. (a). Sample No.APM 12/12 of trace elements against values in ppm. Cd & Ag have given very low value >1 and hence omitted. After plotting the sample values the sample Reg. No. APM- 7/12< 17/12 & 12/12 (meta-pyroxenite with green) highest value of Cr in ppm level. These samples are showing high peak from the 8 analysed samples. Remaining four samples are giving very less Cr- values. Nickel values are showing negative correlation with above the three samples. Three samples of meta-pyroxenite such as APM 10/12, 16/12 and 18/12 are showing high peak values for Ni and Cu is more PPM value in meta-gabbro compared to meta-pyroxenite in all the sample. Co is present in all the samples with less amount. In this diagram Cu,Co,Zn &Ni are gradationally increased quantitatively and showing positive correlation to each eliments**.**

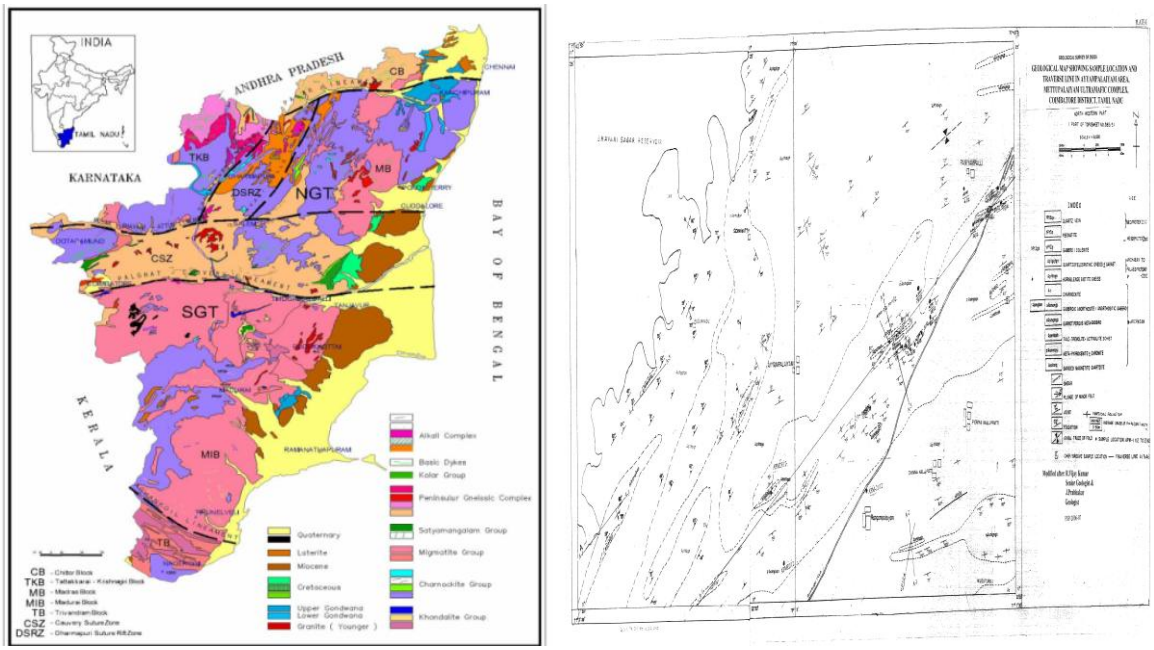


Figure 1: Study Area

Theory and Methodology:

The three-dimensional structure of minerals is defined by regular, repeating planes of atoms that form a crystal lattice. When a focused X-ray beam interacts with these planes of atoms, part of the beam is transmitted, part is absorbed by the sample, part is refracted and scattered, and part is diffracted. Diffraction of an X-ray beam by a crystalline solid is analogous to diffraction of light by droplets of water, producing the familiar rainbow. X-rays are diffracted by each mineral differently, depending on what atoms make up the crystal lattice and how these atoms are arranged.

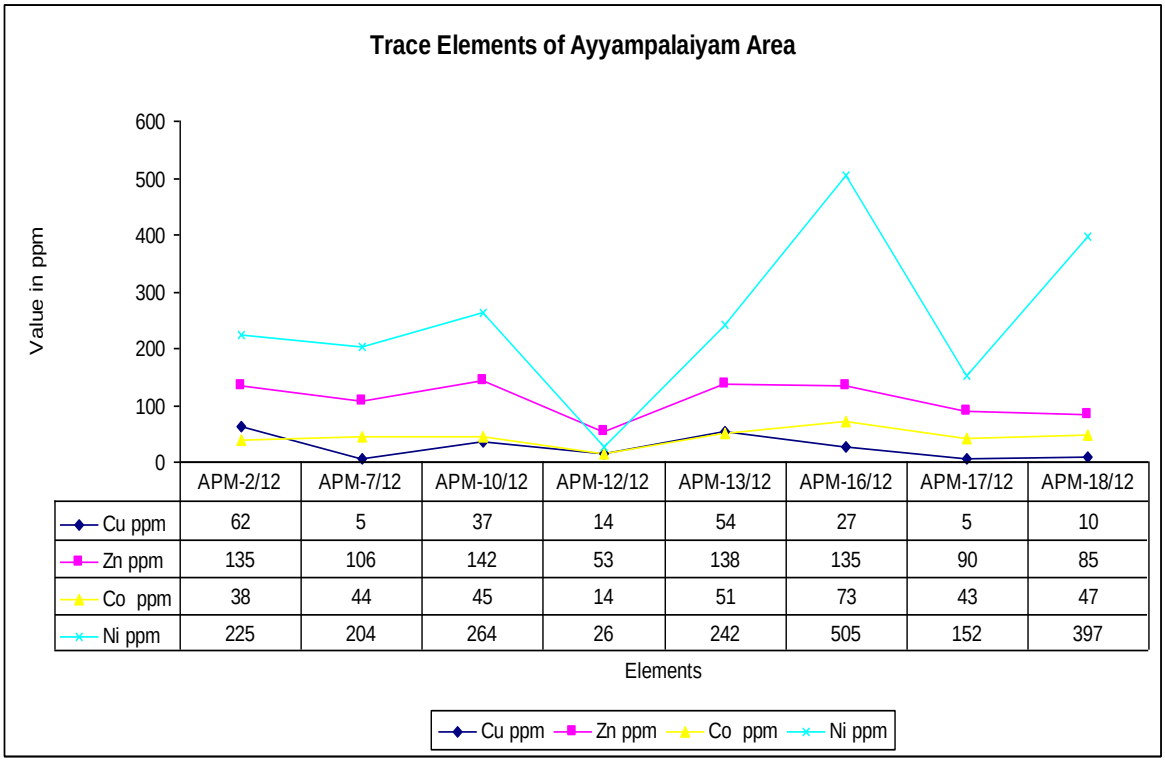
In X-ray powder diffractometry, X-rays are generated within a sealed tube that is under vacuum. A current is applied that heats a filament within the tube, the higher the current the greater the number of electrons emitted from the filament. This generation of electrons is analogous to the production of electrons in a television picture tube. A high voltage, typically 40-45 kilovolts, is applied within the tube. This high voltage accelerates the electrons, which then hit a target, commonly made of copper. When these electrons hit the target, X-rays are produced. The wavelength of these X-rays is characteristic of that target. These X-rays are collimated and directed onto the sample, which has been ground to a fine powder (typically to produce particle sizes of less than 10 microns). A detector detects the X-ray signal; the signal is then processed either by a microprocessor or electronically, converting the signal to a count rate. Changing the angle between the X-ray source, the sample, and the detector at a controlled rate between preset limits is an X-ray scan. When an X-ray beam hits a sample and is diffracted, the distances between the planes of the atoms that constitute the sample are measured by applying Bragg's Law. Bragg's Law is $n\,\lambda = 2\,d\,\sin\theta$, where the integer n is the order of the diffracted beam, λ is the wavelength of the incident X-ray beam, d is the distance between adjacent planes of atoms (the d-spacing), and θ is the angle of incidence of the X-ray beam. Since n is 1 and θ can be measured, d-spacing can be calculated. The geometry of an XRD unit is designed to accommodate this measurement. The characteristic set of d-spacing generated in a typical X-ray scan provides a unique "fingerprint" of the mineral or minerals present

in the sample. When properly interpreted, by comparison with standard reference patterns and measurements, this "fingerprint" allows for identification of the material.

Result:

XRD Analysis:

8 sample has been analysed in this area are shown is lable no.6 sample no. APM-7/12 meta-pyroxenite with green colour is hard specimen. It has given 82% of meganesiohornblende and 9% of tremolite. It means these rocks formed from early crystalization. Sample Reg no. APM 2/12 is gives 79% of tremolite. It means this sample is not comes under meta-gabbro and 19% of megnesiohornblende sample Reg.no 10/12 gives 83% of manesiohornblende with 5% of tremolite. Sample Reg no. APM-12/12 gives like sample No APM-10/12, but in this sample cummingtonite of 9% has formed against of tremolite. Both has given of 2% of titanite element



	APM-2/12	APM-7/12	APM-10/12	APM-12/12	APM-13/12	APM-16/12	APM-17/12	APM-18/12
Cu ppm	62	5	37	14	54	27	5	10
Zn ppm	135	106	142	53	138	135	90	85
Co ppm	38	44	45	14	51	73	43	47
Ni ppm	225	204	264	26	242	505	152	397

sample Reg no. APM 13/12 67% of tremolite, 23% of magnesiohornblende 8% of clinochlore and 2% of titamite. Sample Reg no. APM 16/12 gives 47% of tremolite and 24% of talc with 14% of gedrite and 13% of clinochlore. Sample Reg no. APM- 17/12 gives 50% of magnesiohornblende, 37% of tremolite, 1% of plagioslase feldspar. Sample Reg no 18/12 gives 66% of magnesiohornblende, 18% of tremolite 4% of talc and 3% of ferrogedrite.

Figure 1: Study Area

XRD Analysis Data of Ayyampalaiayam Area:

Table 2

Sample No / Rock Name	**M.Gb APM – 2/12**	**M.Py APM – 7/12**	**M.Py APM - 10/12**	**M.Py APM - 12/12**	**M.Py APM - 13/12**	**M.Py – 16/12**	**M.Py APM - 17/12**	**M.Py APM - 18/12**
Tremolite	79	9	5	-	67	47	37	18
Talc	-	-	<1	-	-	24	-	4
Magnesio hornblende	19	82	83	84	23	-	50	66
Ferro gedrite	2	-	4	-	-	-	-	3
Plagioclase feldspar	-	<1	-	-	-	-	1	-
Titanite	-	-	2	2	2	2	-	-
Cumming tonite	-	-	-	9	-	-	-	-
Gedrite	-	-	-	-	-	14	-	-
Quartz	-	5	-	-	-	-	6	-
Paragasite	-	-	-	-	-	-	-	-
Spessartine	-	-	-	5	-	-	-	-
Clinochlore	<1	3	5	#-	8	13	6	9

Conclusion:

Even the metagabbro samples no APM-2/12 gives more than 3000 ppm of Cr. But more percentage of Fe2O3 is available compare to Solavanur area. FeO (t) rich exposure of metapyroxenite proved based on the field evidence and petrography studies. Predominantly presence of tremolite, hornblende and magnetite

(opaque) in this area. 12 minerl phases have been studied by the XRD and proved the predominant minerals of tremolite and magnesiohornblende with titanite and talc.

- ✓ Major oxides of all samples of mafic and metaultramafic rocks of MgO are showing ranges from 0.64% to 14.47, except two samples no APM 16/12 & 18/12 of meta proxenite are giving 20.44 and 19.51 ppm level.
- ✓ Major oxides of all samples of Fe_2O_3 ranges from 10.63% - 16.59%, except the sample no. APM-12/12. This sample shows highest iron of 28.26% in this area.
- ✓ Major oxides of SiO_2 vs TiO_2 showing sympathetic relation with all other samples, except sample no.APM-17/12. It gives more TiO_2 (1.05) from this area with antisypathetic relation. Only one sample No APM 18-/12 is giving highest SiO_2 against lowest TiO_2 in this area.
- ✓ K_2O content is more in all the samples, except the sample nos. APM 16/12 & 18/12 are giving low percentage.
- ✓ Sample no. APM-16/12 & 18/12 are giving low Al_2O_3 compare to other remaining samples.
- ✓ All the rocks are falling in tholiciitic field with sharp and stright incline line of trend of this metaultramafic suite in AFM diagram.
- ✓ In Diagram SiO_2-K_2O showing the starting of tholeiitic series field.
- ✓ In diagram A/NK (stand 1943) falling in the field of metaalumines field.
- ✓ In TAS diagram (after Cox, Bell & Pang 1979) all samples are falling in the sub-alkaline area and fallingin the field of below the gabbro.
- ✓ In TAS diagram (after Middle most 1985) all the samples are falling in the proper gabbro field, except sample no 18/12. It is falling on the line inbetween gabbro and gabbroic diorite.
- ✓ In diagram R1= 4 Si – 11 (Na+K-2 (Fe+Ti) and R2+ 6 Ca+ 2Mg+Al all the samples are falling inbetween ultrabasic and gabbro norite field nearly gabbronorite field.
- ✓ In diagram Ab-Or-An all the samples are falling from tonalite field to towards a corner.
- ✓ In diagram 10x MnO- $10xP_2O_5$-TiO_2. All the samples are falling in and inbetween continental Arc Besalt and Boninite, except the sample no. APM 7/12. It is falling in the Island Arc Tholeiitic field and sample no. APM-18/12 shows more MnO.
- ✓ In binary variation diagrams SiO_2 vs Al_2O_3, MgO, Mg, A/CNK K_2O/MgO showing sympathetic correlation, except the sample no.APM-18/12 and SiO_2 vs P_2O_5 & $FeO^{(t)}$ are showing sympathetic correlation.

Comparison of Trace Element Analysis Results by XRF & AAS of Ayyampalaiyam Area:

Carried out trace element analysis for eight samples by XRF. All the samples of Cr are showing antisympathetic relation to Ni out of of 8 samples 5 samples are giving more Cr compare to other 3 samples only the sample no APM-18/12 is giving 3316 ppm of Cr and other four samples are giving above 1460 ppm and below 2084 ppm. Some samples have been carried out by AAS out of samples 5 samples are giving more Cr & antisympathic correlation with Ni & Zn. Details are given below:

Table Showing Comparison of Trace Elements by XRF and AAS:

Table 3

Sample No	XRF & AAS		XRF	AAS	XRF	AAS
	Cr ppm	Cr ppm	Ni	Ni	Zn	Zn
APM - 2/12	2045	3000	406	225	146	135
APM - 10/12	2056	6000	438	264	147	142
APM - 13/12	1460	1800	416	242	133	138
APM - 16/12	2084	4500	925	505	134	135
APM - 18/12	3316	7000	671	397	86	85

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