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MINERALOGY AND GEOCHEMISTRY OF PALUNG GRANITE MASSIF

M. P. SHARMA

Department of Geology, Tri-Chandra Campus,
Tribhuvan University, Kathmandu Nepal.

सारांश

मध्य नेपालको महाभारत श्रृङ्खलामा पर्ने ६ वटा ग्रानाईट पिण्डहरू मध्ये एक पालुङ ग्रानाईट हो। यस वहु-चरणीय आग्नेय पिण्ड (Multiphase intrusive) मा मुख्यतः असमान स्थुल कणयुक्त परफिरिटिक टुरमालाईन ग्रानाईट विकसित भएको पाईन्छ। खनिजजन्य तथा भु-रासायनिक अध्ययनबाट के थाहा हुन्छ भने यी ग्रानाईटहरू संभवतः पालिन्जेनेटिक ग्रानिटिक माग्माको लेउकोक्राटीक डिफरेन्सी-एट हुन।

ABSTRACT

Palung massif which has a sharp contact with the country rocks, is one of those six granitic bodies that are situated in the Mahabharat Range of Central Nepal. This massif is a multiphase intrusive containing a number of facies rock varieties. The most widely distributed facies are coarse grained inequigranular porphyritic tourma line granites in the central part and inequigranular tourmaline granites with portions of micropegmatitic texture in the apical part. Mineralogical and geochemical studies reveal that these granites are probably leucocratic differentiate of palingenetic granitic magma.

INTRODUCTION

Palung massif is one of those six granitic bodies that are situated within the Mahabharat Range of Central Nepal (Fig. 1). This massif runs WNW–ESE, pinches gradually in the west and has sharp contact with the country rocks. Radiometric age determined by K/Ar method of muscovite has given the age 51 my to these granites (Khan & Tater, 1970.

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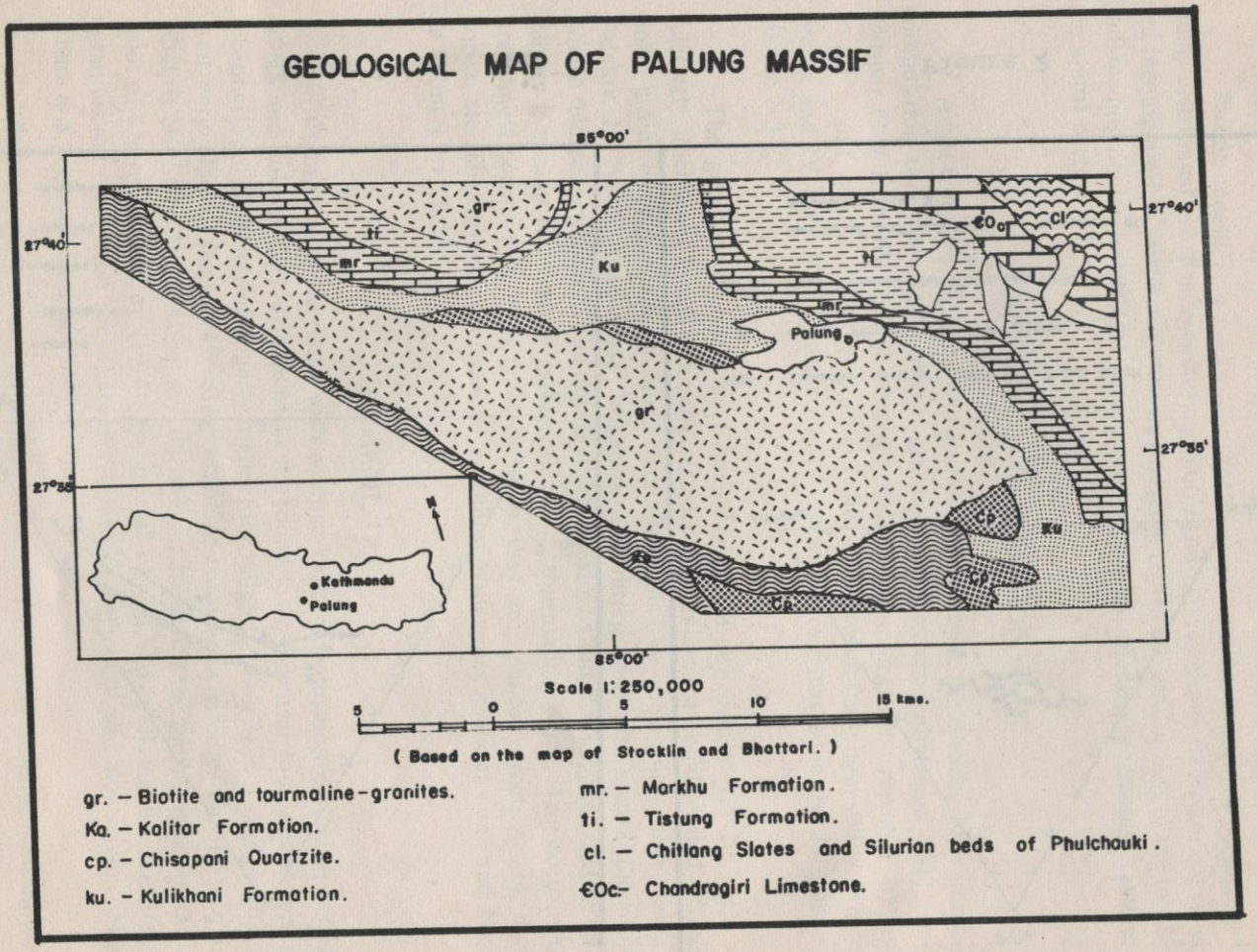

Figure 1: Geological map of Palung massif.

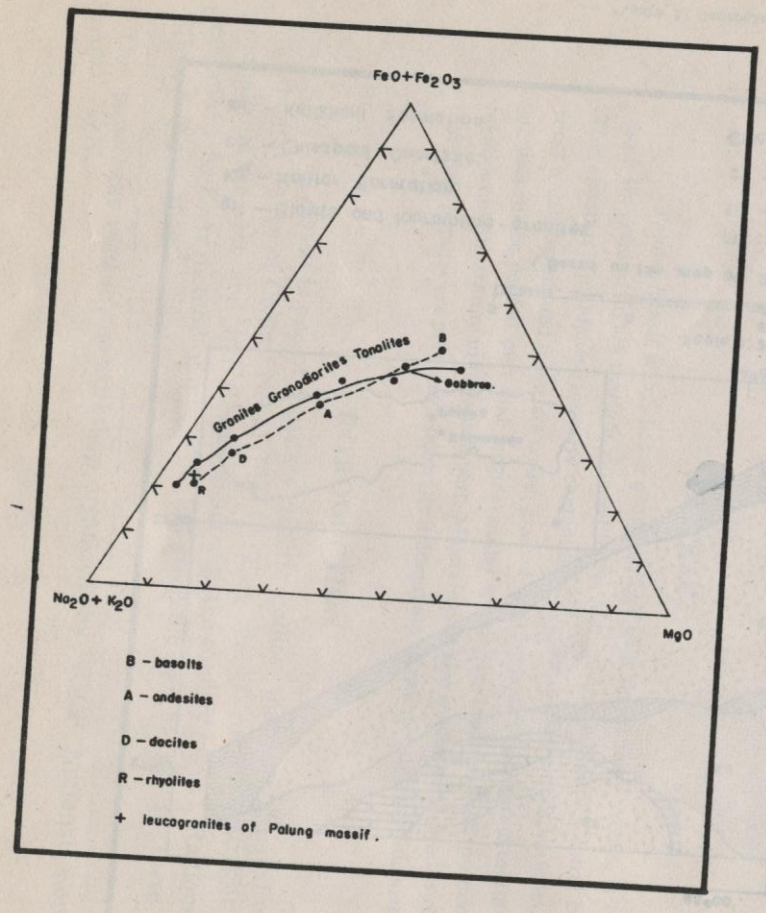

Figure 3

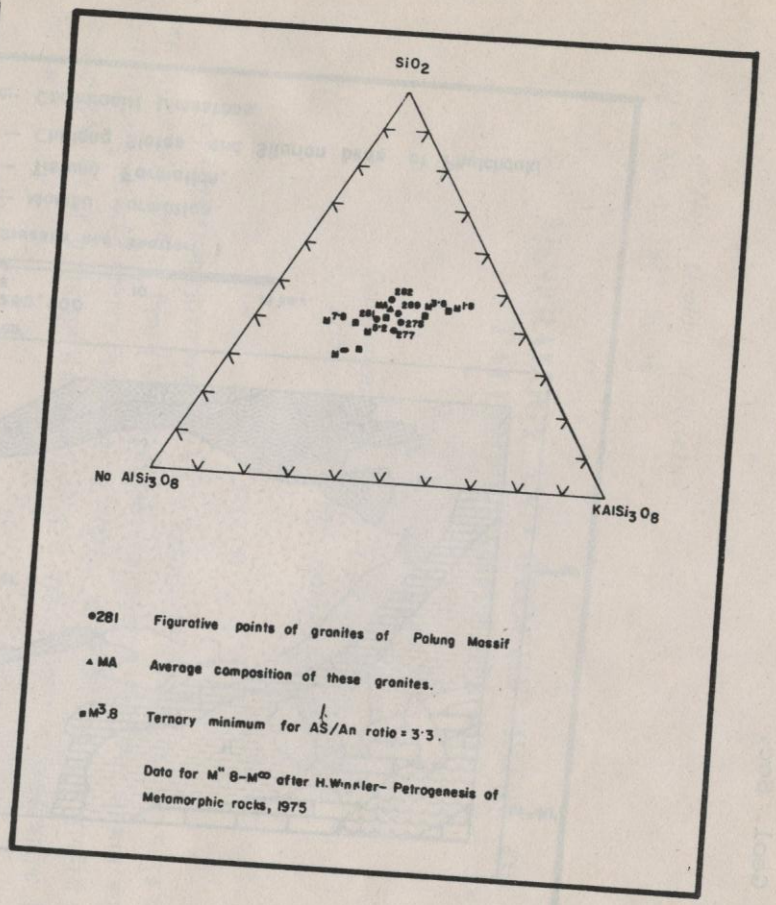

Figure 2

Palung massif is a multiphase intrusive, containing a number of facies. The widely distributed phase is leucocratic granites and most common facies are coarse grained inequigranular porphyritic tourmaline granites (in the central part of the intrusive) and inequigranular tourmaline granites with portions of micropegmatitic texture (in the apical part).

MINERAL COMPOSITION

Apart from the differences in grain size and fabric, these rocks differ in mineral composition also. The coarse grained granites have sericitized oligoclase 40%, potash feldspar (2 V from 65° – 85°), often argillicized and sometimes replaced by albite 20–30% and quartz 20–30%, biotite (with pleochroism from light yellow brown to brown and 2V = 0°–5°) 8%, muscovite (which at places replaces biotite) 20% and tourmaline 2–3%.

The granites of apical part have sericitized oligoclase (15–20 An% with relatively thick twin lamellae having refractive index almost equal to that of quartz. Some grains of plagioclase are more acidic than this (An content not more than 13%, Talalov. 1972). The plagioclase has sometimes intergrowth with quartz almost 40%, potash feldspar argillicized and not rarely replaced by albite 20–30% and quartz 30–40%. Biotite generally replaced by muscovite 5–8%, tourmaline 5–6%. Accessory minerals are almost common in both types of rocks, they are apatite, garnet, zircon, fluorite, topaz, etc. The refractive indices of biotite of both types is about same and Nz=Ny is about 1.61 (Table 1).

GEOCHEMISTRY

Comparing these rocks with average rock composition of Daly (Zavaritsky, 1960) and Solovyov (1970) these rocks are found to be very near to liparities and qaurtz porphyries of Daly having slightly higher SiO_2 slightly lower Fe0 3 and higher Fe0, and very close to the average composition of leucocratic granites of solovyov, having slightly less SiO_2. In the same way, the comparision with the typical rocks in the AFM plot of Charmichael et al. (1974), granites of Palung Shows closer to rhyolites than granites (fig. 2). These rocks are oversaturated with silica and aluminium. Similarly there is a predominance of iron over magnesium.

Spectral analysis as well as heavy fraction from these granites have shown quite high value of tin. Presence of fluorite suggests the high value of flourine content in granitic magma.

Table 1 Refractive indices of biotites of the leucogranites of Palung massif

	Sample No.	Nx	Nz
1.	1	1.613	—
2.	97	1.614	—
3.	135	1.600	1.610
4.	137	1.613	1.616
5.	139	1.575	1.589

Table 2 Atomic abundances of trace elements of the leucogranites of Palung massif

Sample	Si	Al	Mg	Ca	Fe	Mn	Ni	Co	Ti	V	Cr	Mo
1	>3%	>3%	400	3%	3%	40	–	–	60	07	1	–
12	>3%	>3%	3%	2%	>3%	1%	4	–	200	4	3	–
22	>3%	>3%	500	3%	>3%	60	–	–	80	07	1	–
45	>3%	400	>3%	>3%	>3%	>1%	1	06	15	–	–	–
49	>3%	>3%	500	>3%	3%	70	–	02	70	1	1	–
206–1	>3%	>3%	600	>3%	3%	80	05	02	100	08	1	05
240	–	–	–	–	–	50	0.6	0.2	100	3	2	1
242	–	–	–	–	–	10	0.6	0.2	40	1	0.8	1
277	–	–	–	–	–	50	0.3	0.1	80	1	0.6	0.2
278	–	–	–	–	–	50	0.3	0.1	60	0.4	0.6	0.06
281	–	–	–	–	–	50	0.4	0.1	50	0.6	–	0.1
282	–	–	–	–	–	50	0.3	0.3	60	2	0.6	0.1
283	–	–	–	–	–	8	0.3	0.2	60	2	1	0.1
284	–	–	100	–	1%	30	–	–	30	–	3	–
285	–	–	–	–	–	40	0.8	0.1	30	0.3	0.6	0.1
286	–	–	–	–	–	40	0.2	0.1	50	0.6	0.6	0.1
287	–	–	100	–	>1%	30	1	–	30	–	–	–
290	–	–	100	–	>1%	–	1	–	60	3	3	1

Table 2 contd...

Sample	W	Zr	Hf	Nb	Ta	Cu	Pb	Ag	Sb	Bi	Zn	As
1	–	7				08	5	–	–	–	–	–
12	4	6	–	–	–	100	1%	1.5	–	4	> 1%	–
22	6	5	–	–	–	40	6	–	–	?	–	–
45	–	–	–	–	–	40	800	1	–	–	10	–
49	–	7	–	2	–	3	30	–	–	–	5	–
206–1	–	10	–	8	–	1.5	10	–	–	–	15	–
240	–	5	–	–	–	1	1	–		–	–	–
242	–	5	–	–	–	0.5	1	–	–	–	–	–
277	2	4	–	–	–	1	1	0.03	–	0.1	–	–
278	2	3	–	3	–	4	1	0.03	–	0.1	–	–
281	2	3	–	–	–	0.3	0.8	–	–	–	–	–
282	–	4	–	–	–	0.4	1	–	–	–	2	–
283	–	2	–	–	–	0.5	1	–	–	0.1	–	–
284	–	1	–	–	–	1	1	–	–	–	–	–
285	–	1	–	–	–	0.4	0.3	–	–	0.1	–	–
286	–	–	–	–	–	0.6	2	–	–	0.4	–	–
287	–	1	–	–	–	–	1	–	–	–	–	–
290	–	1	–	–	–	1	–	–	–	–	–	–

Sample No	Cd	Sn	Ga	Ge	In	Au	Te	Hg	B	Be	Na	K
1	–	5	1	–	—	Tr	–	6.10^{-6}	–	01	> 1%	> 1%
12	–	–	06		–	Tr	–	–	–	01	–	–
22	–	2	1.5	02	–	–	–	5.10^{-5}	–	03	> 1%	> 1%
45	–	–	–	–	–	–	–	3.10^{-5}	–	007	07	–
49	–	6	1.5	02	–	–	–	3.10^{-5}	–	007	> 1%	> 1%
206–1	–	2	1.5	–	–	–	–	–	–	07	> 1%	> 1%
240	–	0.6	–	–	–	–	–	–	–	< .1	–	–
242	–	–	3	–	–	–	–	–	–	< .1	–	–
277	–	3	6	–	–	–	–	–	–	< .1	–	–
278	–	3	6	–	–	–	–	–	–	< .1	–	–
281	–	2	5							< .1	–	–
282	–	1	5							< .1	–	–
283	–	0.6	5							< .1	–	–
284	–	1	1							–	> 1%	–

Table 2 contd...

285	–	1	6									
286	–	0.6	6	–	–	–	–	–	–	.1	–	–
287	–	1	1	–	–	–	–	–	–	<.1	–	–
290	–	3	–	–	–	–	–	–	–	–	>1%	–
										–	>1%	–

Sample No	Li	Sr	Ba	P	Sc	Y	Yb	La
1	30	10	–	–	–	1	04	–
12	–	10	1%	–	–	–	04	–
22	150	10	7	–	–	2	05	–
45	–	15	–	–	–	10	1	–
49	40	10	–	20	–	4	07	–
206–1	15	30	6	–	–	15	1	–
240	–	–	40	–	0.6	3	.3	–
242	–	–	30	–	–	.8	0.03	–
277	100	–	80	–	–	0.15	0.1	–
278	100	–	20	–	–	0.15	0.1	–
281	60	–	10	–	–	0.15	0.2	–
282	60	–	30	–	–	0.15	0.1	–
283	–	–	30	–	–	1	0.1	–
284	30	–	50	–	–	–	–	–
285	20	–	–	–	–	0.6	0.06	–
286	30	–	30	–	–	0.1	0.01	–
287	30	–	30	–	–	–	–	–
290	30	30	30	–	–	–	1	–

The analysis also shows high content of Li . W, Nb, Ta, etc., in some places several times more than the Clarke value (table 2).

DISCSSUION

These granites have less than 10% dark coloured minerals. From the chemical analysis of these rocks (table 3) it can be seen that SiO_2 is more than 71%, melanocratic components are less than 4% and CaO less than 1.2%. Thus these granites seem to be leucocratic differentiate (the last differentiate, liparite) of big abyssal palingenetic granitic magma of calc-alkali series as Rittmans index 'S' of these granites

is about 2 (Barth, 1962, table 4). This reflects the general tendency of changing the rock composition towards the end stages of development of the magmatic chamber and can be considered that these granites are the roots of potential erruption of liparites and quartz porphyries which did not take place.

The points of norm values of quartz, albite and potash feldspar are computed in percentages in the diagram of minimum temperature melt of the system of Q–Ab–AN–Or–H_2O projected onto the Ab–Or–Q base at P_{H_2O} of 2 Kbar (Winkler, 1974) are located near the point of the composition of minimum temperature melt, containing anorthite when Ab/An ratio = 5.2. The Ab/An ratio of the leucocratic granites of Palung massif is about 5 (fig.3). This confirms the idea that the magma which produced these granites was the differentiate of palingenetic granitic magma and the last crystallization temperature may be around 685° C. (fluorine and other magmaphyllic components are not counted).

As mentioned earlier the refractive indices of biotite were measured and were found that $N_Z=N_y$ is around 1.61. The low value of refractive indices shows that the biotite has low value of ferrogenosity which is but natural because the rocks have high aluminosity value and sufficiently high chemical potential of water (Masakushev, 1976).

The predominance of iron over magnesium, the presence of fluorites in the rocks as well as the location of points in Winkeler's diagram (Winkeler, 1974) point to low temperature of formation of these hypabyssal granites as compared with earlier phases. Naturally, it proves the differentiation (evolution) of parent granitic magma having more and more magmaphyllic components (fluorine, boron, water) at the stages of differentiation.

CONCLUSION

Comparing with other granites that are being studied under the IGCP Project No. 26 (Metalisation ., 1974) which deals with, among others tin and tungsten mineralization associated with graintes. These granites have as well gone through the auto metasomatic late magmatic processes leading to microclinization. tourmalinization, and slightly alibitization and the postmagmatic metasomatism that is greisenization. If the chemical analysis are compared these granites of Palung massif are near to the plumasitic, rare metallic leucogranire of L. V. Tauson (Tauson, 1977) classification. These plumasitic granites are generally sharply enriched, specially in the roof portion of the body by such rare elements as lithium, rubidium, tin, tungsten, neobium, tantalum,

Table 3 Chemical composition and notm rminerals of leucogranites of Palung massif

Content in % Oxides

Sample No.	Sio_2	Tio_2	Al_2o_3	Fe_2o_3	Feo	Mno	Mgo	Cao	Na_2o	K_2o	Ignition lcss	P_2c_5	So_3	Total
277	73.38	0.24	13.20	0.33	1.79	0.07	0.43	5.08	3.10	4.52	0.96	0.23	0.10	99.43
278	73.82	0.11	13.80	0.62	1.39	0.06	0.35	1.21	3.37	3.97	0.84	0.21	0.05	99.77
280	76.36	0.25	11.89	1.19	1.50	0.08	0.78	1.33	2.56	3.73	0.52	0.15	0.07	100.41
281	74.24	0.11	13.28	0.87	1.14	0.07	0.36	0.96	3.23	4.09	0.74	0.18	0.05	99.31
282	73.70	0.29	13.55	0.53	1.72	0.07	0.52	1.45	2.69	3.97	0.96	0.16	0.04	99.84
283	74.82	0.29	13.56	0.78	1.22	0.02	0.43	0.96	2.56	3.37	1.02	0.12	0.07	99.06
285	75.22	0.01	13.86	0.91	0.70	0.06	0.35	1.21	3.37	3.25	0.64	0.20	0.05	99.92
286	73.76	0.08	14.11	1.23	1.14	0.04	0.17	1.45	0.62	3.37	3.37	0.19	0.04	99.57
289	73.00	0.24	13.46	1.34	1.36	0.05	0.87	1.21	2.83	4.22	0.80	0.15	0.06	99.59
291	60.30	0.79	15.29	1.73	6.46	0.09	2.52	2.29	3.50	2.65	1.12	0.18	0.04	99.87

Sample No	Il	ap	cr	ab	an	mt	hy	c	Q
277	0.46	0.34	26.71	26.22	4.73	0.46	3.87	1.43	34.0
278	0.15	0.34	23.37	28.31	5.01	0.93	2.78	2.14	35.64
280	0.46	0.34	21.70	21.50	5.84	1.62	3.40	1.63	43.10
281	0.15	0.34	24.49	27.26	3.89	1.39	2.19	2.04	36.78
282	0.61	0.34	22.26	23.07	6.4	0.93	3.55	2.75	38.82
283	0.30	0.34	22.03	21.50	3.89	1.16	2.32	4.28	44.14
285	–	0.34	19.48	28.31	5.01	1.39	1.46	2.96	40.18
286	0.15	0.34	20.03	5.24	6.40	1.86	1.32	7.03	53.80
289	0.46	0.34	25.04	24.12	5.01	1.86	3.40	2.35	36.12
291	1.37	0.34	15.58	29.36	10.57	2.55	15.69	2.75	18.00

Analytical results after Talalov, 1972

Sample No. 277 granites lying at some distance from the contact.
Sample No. 278 "
Sample No. 280 granites of the northern contact.
Sample No. 281 granites occuring 150 m. north of the sourthern contact.
" 282 granites.
" 283 granitized sandstone.
" 285 granitized sandstone.
" 286 fine-grained aplite like tourmaline granite in sandstones parallel to contact.
" 289 granite
" 291 Xenolith.

Table 4 Rittman's Index 'S' for the Leucogranites of Palung massif

S_{277}	—	1.91
S_{278}	—	1.72
S_{280}	—	1.19
S_{281}	—	1.71
S_{282}	—	1.44
S_{283}	—	1.10
S_{285}	—	1.36
S_{286}	—	1.42
S_{289}	—	1.66
S_{291}	—	2.18

Analyses after Talalov (1972)

berillium, fluorine and others. Not rarely the concentration of these elements reach economic level.

Therefore it is worchwhile to study different phases of the massif in detail, their relation with each other, their geochemistry, specially the geochemistry of fluorine and other volatiles and their roles in the evolution of magmas.

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