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Progressive metamorphism and geochemistry of hornblendes from Mailaram-Palvoncha area, Khammam District, A.P.

Y. JANARDAN RAO AND K. SATYANARAYANA

Abstract

Hornblendes and their host rock amphibolites from amphibolite facies and hornblende-granulite sub-facies were analysed for major elements. The hornblendes show small changes in chemistry which are related to host rock compositional changes rather than the pressure and temperatures condition of formation.

Introduction

In areas of regional metamorphism, progressive changes in the chemistry of hornblendes are noticed when the minerals studied are from amphibolites but occurring in different metomorphic grades. While some workers attribute these changes to varying pressure and temperature conditions from place to place (Ramberg 1952) some believe that the compositional change is mainly based on host rock composition (Engel and Engel, 1962; Leake, 1965). In the area under investigation (Fig. 1) amphibolites and hornblende schists occur around Mailaram and pyroxene-bearing garnetiferous amphibolites are exposed in Palvoncha. The amphibolites are massive whereas the hornblende schists show well developed schistosity and lineation. All these rocks occur as lenses and interlayers in the gneissic country rock. On the basis of petrological studies, it was suggested that the Mailaram amphibolites belong to amphibolite facies and Palvoncha amphibolites to hornblende-granulite sub-facies and that there is a progressive increase in metamorphism from Mailaram to Palvoncha (Satyanarayana, 1970). Hornblendes and their host rock amphibolites from both Mailaram and Palvoncha were analysed and an attempt is made to see whether the changes in chemistry of hornblendes are due to the changes in host rock composition or due to metamorphic grade.

Mineralogy

The modal compositions given in the Table I show that hornblende is the major constituent in both these amphibolites. In Mailaram amphibolite, hornblende is bluish green in colour, prismatic in form; sp. gr. 3.01, $2V = -62$ to $72°$; $Z \wedge c = 18$ to $20°$; birefringence 0.016; X = yellowish green; Y = pale green and Z = bluish green.

The Palvoncha hornblende is yellowish green in colour; sp. gr. 3.10; $2V = -60$ to $80°$; $Z \wedge c = 16$ to $18°$; birefringence = 0.018; X = pale yellow; Y = pale yellowish green and Z = yellowish green.

Plagioclase is the other important mineral in these amphibolites. The anorthite content ranges from 16 to 25% in Mailaram amphibolite to 35 to 55% in Palvoncha amphibolite. Palvoncha amphibolites also contain pyroxene and garnet and the latter sometimes occur as coronas in these rocks (Janardan Rao and Satyanarayana, 1969).

Chemistry of the Hornblendes

Two hornblendes and their host rocks from Mailaram and Palvoncha were analysed and the data presented in Table I. These hornblendes show slight

TABLE I

CHEMICAL COMPOSITION OF HORNBLENDES AND THEIR HOST ROCKS ALONG WITH THE MODE OF HOST ROCKS AND STRUCTURAL FORMULAE OF HORNBLENDES

	Amphibolites		Hornblendes	
	Mailaram	Palvoncha	Mailaram	Palvoncha
SiO_2	46.78	48.07	40.68	42.26
TiO_2	1.06	0.35	1.16	0.51
Al_2O_3	15.54	15.72	15.25	15.28
Fe_2O_3	3.87	1.23	4.52	2.35
FeO	11.35	10.30	14.74	13.51
MgO	7.13	7.49	9.16	11.20
CaO	9.80	11.61	11.15	12.32
Na_2O	2.42	3.88	1.02	1.08
K_2O	0.78	0.43	0.82	0.68
P_2O_5	0.16	tr	0.03	0.03
MnO	0.25	0.01	0.33	0.15
H_2O^+	0.68	0.45	0.39	0.33
Mg/Mg+Fe	0.32	0.36	0.33	0.39
Fe_2O_3/FeO	0.34	0.12	0.30	0.17
Fe/Mg	2.06	1.79	2.11	1.58

	MODE		STRUCTURAL FORMULAE		
Hornblende	63%	53%	Si	6.24	6.38
Plagioclase	12%	16%	Al^4	1.76	1.62
Clinopyroxene	×	12%	Al^6	0.99	1.09
Quartz	19%	4%	Ti^3	0.13	0.06
Garnet	×	9%	Fe^3	0.52	0.27
Others	6%	6%	Fe^2	1.91	1.70
			Mn	0.04	0.02
			Mg	2.11	2.54
			Ca	1.83	1.99
			Na	0.32	0.30
			K	0.16	0.13
			OH	0.39	0.33

Analysed by Andhra Pradesh Mining Corporation, Hyderabad, following classical methods.

changes in their chemistry as can be seen from their chemical analysis and structural formulae (Table I). They are calciferous types as they contain 1.83 to 1.99 Ca ions (Boyd, 1959).

Discussion

The colour and density changes of the hornblende between Mailaram and Palvoncha are similar to those reported by Engel and Engel (1962) in Northwest Adirondack Mountains. The colour of hornblende changes from bluish green to yellowish green and density from 3.01 to 3.10 between Mailaram and Palvoncha areas.

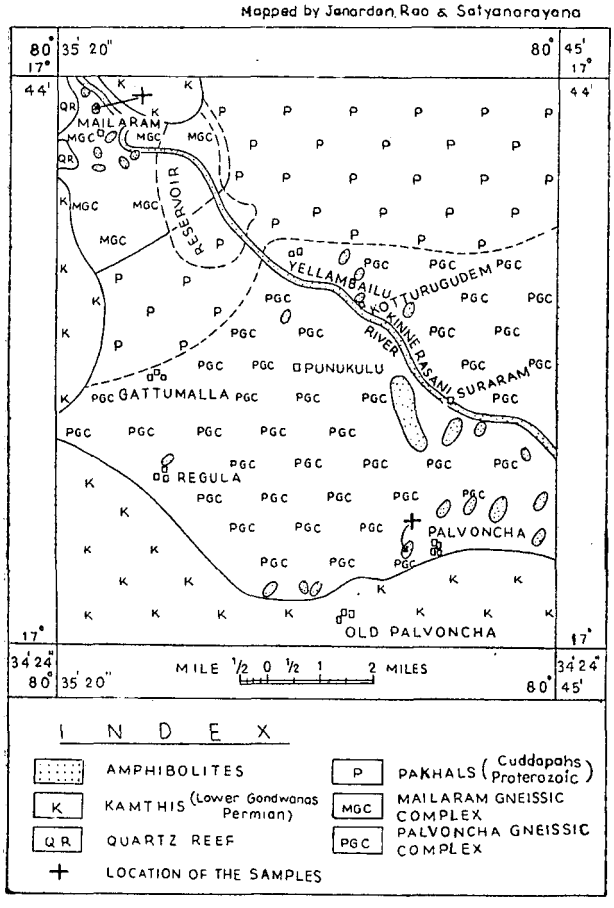

Figure 1. Geological map of Mailaram—Palvoncha area.

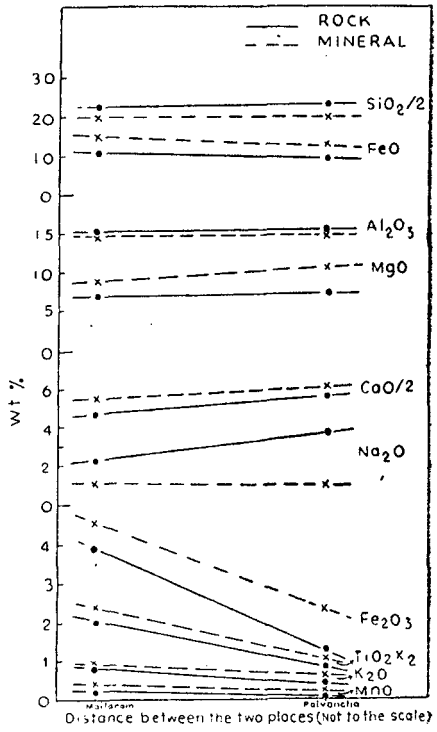

Figure 2. Lines showing changes in chemical composition of hornblendes and their host rocks between Mailaram and Palvoncha.

The Mailaram hornblende formed in amphibolitic rock under the amphibolite facies conditions contains more Fe_2O_3, TiO_2, FeO, MnO, K_2O and H_2O and less SiO_2, CaO, MgO than the Palvoncha hornblende which is also from amphibolitic rocks but formed under hornblende granulite sub-facies conditions. Similar chemical changes for the above oxides can also be noticed in their corresponding host rocks. These changes are clearly brought out in Fig. 2, from which it is apparent that there is an increase of CaO, Na_2O, and decrease of FeO, Fe_2O_3, TiO_2, K_2O and MnO and slight increase in SiO_2, Al_2O_3 and MgO from amphibolites of Mailaram to Palvoncha and corresponding changes of the same elements are also noticed from Mailaram to Palvoncha hornblendes.

With increasing grade of metamorphism, progressive increase in the replacement of Si by Al is reported in the hornblende chemistry (Harry, 1950). But according to Shido and Miyashiro (1959) progressive increase in the replacement of Si by Al is not apparent with increase of metamorphism in the basic rocks of the Central Abukuma Plateau, Japan. In the present area, the hornblende from the high grade Palvoncha amphibolite contains less Al^4 than that from low grade amphibolite (1.76). Within wide range of P and T, the composition of hornblende is mainly controlled by host rock or magma composition. This is particularly so for Mg/Mg + Fe ratios in hornblendes, which are almost entirely dependent on the Mg/(Mg + Fe) ratios in the host rock or magma (Harry 1950). In these hornblendes, not only Mg/(Mg + Fe) ratio, but also $\frac{Fe_2O_3}{FeO}$, $\frac{Fe}{Mg}$ and all the elements analysed entirely depend on the elements present in their host rock. Thus the increase or decrease of the various elements and ratios in hornblendes with progressive metamorphism from Mailaram to Palvoncha is closely related to corresponding changes in the host rock chemistry.

It is probable that in the hornblendes of Mailaram and Palvoncha areas of Khammam District, the small changes in chemistry appear to be not due to differences in their pressure-temperature conditions of formation, but influenced greatly by slight but significant differences in the chemical composition of their host rocks.

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Address of the authors

Y. JANARDAN RAO and K. SATYANARAYANA, Geology Department, Osmania University, Hyderabad 7.