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Allanite in charnockites from Air Port Hill, Visakhapatnam, Andhra Pradesh, India

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Abstract

The first known occurrence of allanite from charnockites of the Eastern Ghats of Visakhapatnam, Andhra Pradesh, India, is reported. Chemical and spectrographic analysis and X-ray powder data are presented. The allanite belongs to a late paragenetic sequence in the coarse palingenetic charnockites and charnockite pegmatites which are derived from the structurally emplaced igneous charnockites during granulite-grade metamorphism.

Introduction

The hill, Δ 136′, near the Visakhapatnam Air Port is an inselberg made up of charnockites, pyroxene granulites, and charnockite pegmatites. Allanite is observed in the palingenetic charnockites and charnockite pegmatites and is the first reported occurrence from Visakhapatnam in the Eastern Ghats. The charnockites (hypersthene granites, granodiorites, and enderbites) occupy the core and axial portion of the overturned isoclinal folds of khondalites (garnet–sillimanite gneisses, quartzites, and calc-granulites) and are probably plutonic igneous bodies. These are intruded by basic rocks (norites and gabbros), which later suffered granulite-grade metamorphism. The charnockites and khondalites attained the palingenetic state and gave rise to palingenetic hypersthene granites and pegmatites; basic rocks changed to pyroxene ± hornblende and garnet granulites. During the crystallization of pegmatites, the allanite crystallized at a late stage and concentrated in the inner part of the pegmatite veins. However, in the palingenetic hypersthene granites, allanite occurs as disseminated grains. This indicates a higher fluid content in the pegmatite veins than in the palingenetic charnockite.

The age of allanite from apatite–magnetite deposits, described as fracture-filling skarn veins having pegmatitic fabric in the charnockites (Rao, 1976), of Kasipatnam is 1,900–2,100 m.y. (Vinogradov *et al.*, 1964). The NW-trending pegmatites under study may be coeval with the NW-trending skarn veins of Kasipatnam in Visakhapatnam district. It is inferred from the present study and that of Vinogradov *et al.* (1964)

Tale 1. Chemical analysis of allanite from Air Port Hill charnockite, Visakhapatnam

Oxide	Wt %	Number of ions on the basis of 13(O,OH)		
SiO_2	31.24	Si	2.9325	3.000
TiO_2	1.67	Al	0.0675	
Al_2O_3	14.79	Al	1.5657	1.926
Fe_2O_3	5.10	Fe^{3+}	0.3604	
FeO	8.49	Mg	0.1661	0.957
MnO	0.28	Ti	0.1182	
MgO	1.18	Fe^{2+}	0.6645	
CaO	11.01	Zr	0.0084	
*$(Ce,La,Nd)_2O_3$	23.29	Mn	0.0225	1.966
*ThO_2	0.50	Y	0.0081	
*U_3O_8	0.01	Ca	1.1072	
*Y_2O_3	0.15	Th	0.0218	
*V_2O_3	0.09	Ce	0.7997	
*ZrO_2	0.15	U	0.0002	
*PbO	0.04	V	0.0064	
*SnO_2	0.03	OH	1.374	
H_2O+	2.20			
H_2O-	0.08			
Total	100.30			

Be = <4, Mo = 60, Sc = 150, Ge = 80, Nb = 900, Zn = 140, Au = 10, W = <40, Co = 150, Ca = 30, Sr = 480, Cu = 150, Cr = 70, Ni = 66 (in ppm; Instrument: Yvon Z-3 Large Quartz Prism Spectrograph).

*Neutron activation analysis (elemental determinations are converted into oxides). All other oxides are determined by classical analysis.

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and Crawford (1974) that the charnockites in Visakhapatnam were emplaced at about 2,600 m.y. and suffered palingenesis in places around 2,000 m.y.

Mineralogy

Allanite is dark brownish to black and occasionally forms euhedral crystals (3″ × 2″). It is opaque and characterized by anastomosing cracks. The heated sample is pleochroic and gave the following properties: α = 1.754, light brown; β = 1.780, orange brown; γ = 1.785, deep brown to greenish brown; $2V$ = (−) 85°; G = 3.90. The chemical analysis and trace-element content of allanite from the Air Port Hill charnockite are listed in Table 1. U, Th, and rare earths substitute for cerium. Co, Ni, Cu, and Cr may substitute for iron and Sr for Ca. The concentration of Mo indicates its enrichment at the time of crystallization of allanite during the hydrothermal stage. The X-ray powder data for this allanite agree with those published by Frondel (1964).

Paragenesis

The structurally intruded charnockites were subjected to granulite-grade metamorphism. The coarse-grained palingenetic charnockites are confined to the outer margins of the inselberg. In these rocks, charnockite pegmatites are segregated along NW-trending fractures. The pegmatites show inward coarsening, and their thickness varies from 5 to 10 cm. Allanite occurs in the core of the pegmatites. The embayment and replacement of the charnockite assemblage—orthopyroxene (En_{44-50}), garnet ($Al_{70}Py_{21}Gr_6An_2Sp_1$), iron-rich biotite, orthoclase perthite ($Or_{80}Ab_{15}An_5$), plagioclase (An_{30-42}) and quartz—by allanite (± apatite) indicate later crystallization of these in sequence. Also, sulphides, *i.e.*, pyrite, pyrrhotite, chalcopyrite, are found enclosing and transecting the above minerals. The replacement of orthoclase perthite by allanite indicates that the unmixing of the feldspar belongs to an early phase which was completed before hydrothermal minerals (allanite ± apatite ± sulphide minerals) began to crystallize. The allanite might have formed during metamorphism from the biotite, plagioclase, and accessory monazite present in the charnockites.

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