En OF ORTHOPYROXENES AND *An* OF PLAGIOCLASES FROM KONDAPALLI: COMPARISON BETWEEN THE CHEMICAL AND NORMATIVE VALUES

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The primary purpose of this communication is to present a comparative picture of the chemically analyzed and normatively computed compositions of orthopyroxenes (*En* contents) and plagioclase feldspars (*An* contents) from the charnockitic rocks of Kondapalli in Andhra Pradesh.

Separating techniques employed to obtain pure mineral concentrates from the host rocks are given elsewhere (Leelanandam, 1968a, 1968b), and the analyses of orthopyroxenes obtained by classical chemical methods are already available (Leelanandam, 1967). The alkalies and lime in plagioclase feldspar separates were determined by flame photometer and EDTA titration, respectively. The chemical compositions of plagioclase feldspars, and normative compositions of both plagioclase feldspars and orthopyroxenes (deduced from the wet chemical analyses of the whole rocks), presented in Table 1, were extracted from the unpublished Ph.D. thesis of Leelanandam (1965).

In the mafic granulites (previously designated as basic charnockites), the remarkable feature is the striking similarity of the compositional values obtained by chemical analysis and by norm calculations, for both orthopyroxenes and plagioclase feldspars, consistently in all the samples with no exceptions (*see* Table 1); in most cases, the difference is much less than 2%, and the chemical and normative *En*

Table 1. Chemical and normative compositions of orthopyroxenes and plagioclase feldspars (*Analyst:* C. Leelanandam)

Sample No.		*En* in orthopyroxene		*An* in plagioclase	
Mafic granulites*		Chem. analysis*	Norm	Chem. analysis	Norm
28	(96256)#	58.09	58.74	83.76 (L) 88.30 (H)	84.37
61	(96265)	57.19	56.38	80.86	81.80'
G17	(96258)	55.27	57.07	56.59 (L) 60.87 (H)	59.42
220	(96252)	54.55	56.14	n.a.	60.41
474	(96257)	54.46	56.85	n.a.	62.76
P45	(96259)	52.88	52.58	81.05	83.52
A18	(96251)	48.31	46.24	55.98 (L)@ 73.40 (H)	61.79
Felsic granulites*					
382	(96273)	50.77	51.45	55.11	56.91
62	(96275)	50.34	49.83	44.91(L) 46.34 (H)	44.63
M12	(96281)	48.34	25.39	37.78	39.79
B4	(96282)	45.26	41.29	43.86	45.46
S1	(96280)	43.15	36.16	39.71	38.37
322	(96293)	41.87	38.35	54.45	53.55

* see Leelanandam (1967) for the orthopyroxene analyses, mineral assemblages of the host rocks and localities.
# The five-digit numbers of specimens correspond to those catalogued in the Harker Collection at the Department of Mineralogy and Petrology, Cambridge (UK).
@ see Leelanandam (1968b); n.a. = not available; L = Light fraction; H = heavy fraction. The proportions of light and heavy fractions of plagioclase in samples 28, G17, A18 and 62 are not estimated.

values are remarkably close and virtually indistinguishable in some cases (as in the samples 28 and P45). Orthopyroxene and plagioclase are the two predominant minerals in mafic granulites, and the presence of non-normative minerals like hornblende, biotite and garnet in sub-ordinate amounts (though not inconsequential in some cases) does not seem to exert any perceptible influence in disturbing the "true" *En* and *An* values in norm calculations. Though this is somewhat surprising, it is not totally unexpected taking into consideration the trivial contribution (disturbance) the non-normative minerals can make (either in absolute values or relative proportions among Ca, Mg and Fe^{2+}) in the formation of normative minerals. For a full account of the minor but persistent differences in Fe^{2+}/Mg values of the coexisting mineral phases and of the low but consistent K_D (Fe^{2+}/Mg) values for different sets of mineral pairs, see Leelanandam (1967, 1970). The *En* values of orthopyroxenes are practically unaffected by the small and variable amounts of Fe-Ti oxides, as TiO_2 and Fe_2O_3 combine with the requisite amounts of FeO to form normative ilmenite and magnetite respectively.

In the felsic granulites (previously designated as acid and intermediate charnockites), the total absence (or extreme scarcity) of Ca-bearing minerals such as clinopyroxene and hornblende in the modes, is solely responsible for the extraordinary similarity between the chemical and normative *An* values of plagioclase feldspars (*see* Table 1). Orthopyroxene, though ubiquitous, is scarce and, it sometimes occurs even in trace amounts, having abnormally low normative *En* values in garnetiferous varieties. This needs an explanation. Insignificant modal garnet (with extremely high Fe^{2+}/Mg values of 2.9 in the sample M12 and 4.3 in the sample S1 in comparison with those of coexisting orthopyroxene 1.1 in M12 and 1.3 in S1) can significantly lower the normative *En* values. The relative modal abundances of garnet and orthopyroxene are much more crucial than the large differences in their Fe^{2+}/Mg values. Thus, in the samples M12 and S1, modal garnet (3-4%), far in excess of orthopyroxene (< 1.5%), is responsible for the unusually lower normative *En* values in comparison to chemical *En* values of orthopyroxenes (Table 1). In the samples of B4 and 322, modal garnet is less than modal orthopyroxene (<3%), and hence the discrepancies are not that drastic. While garnet is absent in the sample 62, the amount of garnet in the sample 382 is insignificant relative to that of orthopyroxene, and hence the very impressive similarity between the chemical and normative *En* values (Table 1). The minor but not meagre amounts of Fe-Ti oxides do not appear to play any recognizable role in altering the normative *En* values of orthopyroxenes for the reasons already given.

Summarizing, it is concluded that the researchers on mafic and felsic granulites (with propitious mineral assemblages) can conveniently take solace in confidently utilizing the normative compositions of minerals, in case the mineral analyses are not available, if only the whole rock analyses (including the FeO determinations) are of proven superior quality. However, caution should be exercised in dealing with the garnet-bearing felsic granulites, as they are particularly vulnerable to yield exceedingly low normative *En* values for orthopyroxenes. The present study additionally demonstrates that the amazing similarity of the chemical and normative compositions of Kondapalli orthopyroxenes and plagioclase feldspars (as expressed by *En* and *An* contents respectively), bear testimony to the high purity of mineral concentrates and to the great accuracy of the chemical analyses of both minerals and rocks.

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