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A note on the origin of chrome grossular garnet (uvarovite) in calc-silicate from Bandihalli, Tumkur District, Karnataka

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Abstract

The green garnets found in the calc-silicate horizons around Bandihalli, is a chrome grossular (~ 7% Cr_2O_3) with appreciable amount of Mn content. Thus, a partial miscibility between uvarovite and spessartite end members appears possible. The occurrence of thin band of graphite bearing quartzite within the calc-silicate horizons points to its metasedimentary origin. The presence of another variety of garnet (pyrope-almandine rich) in the associated cordierite bearing rock of the area shows that the composition of garnet may not be wholly dependant on grade of metamorphism.

Introduction

Chrome garnet was first reported from Bandihalli (Long. 77°1'30" Lat. 12°46'15") by Jayaram (1926) from a calc-silicate rock associated with metasediments and basic sills. The mode of origin of the chrome garnet, its chemistry and the source for the chromium content have not been discussed earlier. The garnet is interesting because of its appreciable spessartite content. The present note concerns itself with the chemistry and the origin of garnet.

The associated rock types include cord+anth±sill±gar granulite, hornblendite, amphibolite, actinolite schist, graphite-quartzites, ferruginous quartzites, tourmaline pegmatites and dolerites. All these now occur as enclaves in the migmatitic gneisses. Based on the geological set up—lithological and mineral assemblages, the rock types have been included in the 'Sargur Schist Complex'.

The general structure of the area indicates a broad fold closure plunging south and the calc-silicate band, significantly occupies the fold closure. The calc-silicate band is sandwiched between two ultramafic sills (?). The band itself is well foliated with steep dips (Fig. 1). Diopside rich basic veins lace the calc-silicate rock. A thin band of graphite-quartzite (0.5 to 1 m thick) is found well within the calc-silicate rock. The green garnets are mainly concentrated along the foliation planes and the contact of basic veins, with high crystallinity pointing to its late formation.

Petrography:

The calc-silicate rock, which contains the green garnet, is composed of mafic bands rich in cpx + bluish green amphibole and leucocratic bands consisting of calcite + clinozoisite/epidote + plagioclase + quartz. Sphene, magnetite and scapolite form the accessories. The graphite-quartzite band is made up of recrystallised graphite, sericite and quartz.

Porphyroblastic green garnets exhibit inclusions of clinozoisite/epidote and quartz (Fig. 2). Garnet has formed at the expense of these minerals and the associated calcite during subsequent metamorphism.

Chemistry:

The chemical analyses of green garnet and associated clionopyroxene, as also the chemical composition of the host rocks and associated basic sills are presented

in Table I. The garnet has high CaO and low Cr_2O_3 to call it as 'Uvarovite'. It can be termed as 'chrome-grossular'.

TABLE I. Chemical analyses

	Minerals				Rocks		
	1	2	3	4	5	6	7
SiO_2	36.09	33.81	41.23	44.20	51.93	50.05	44.07
TiO_2	—	0.60	0.37	0 59	0.62	0.70	0.64
Al_2O_3	9.83	13.80	20.32	4 67	8.56	18.07	15.46
Fe_2O_3	8.64	5.98	0.88	0.43	0.41	0.60	3.76
FeO	0.50	0.77	19.20	7 04	6.10	11.32	11.70
MnO	3.75	4.49	1.80	0 59	0.53	0.32	0.34
MgO	—	0.61	13.14	18.44	9.60	12.61	6.67
CaO	31.20	32.50	3.14	22 16	18.79	2.56	12.06
Cr_2O_3	9.83	7.10	—	—	0.56	—	0 35
Na_2O	—	—	—	—	0.25	0.44	1.85
K_2O	—	—	—	—	0.56	2.10	0.88
LOI	nd	nd	nd	nd	3.10	1.18	2.20
a(Å)	11.860	11.820*	11.560*	—	—	—	—
Grossular	30.80	46.69	4.23	—	—	—	—
Andradite	27.43	18.92	3.92	—	—	—	—
Spessartite	8.72	9.39	3.75	—	—	—	—
Almandine	1.15	1.69	39.50	—	—	—	—
Pyrope	—	2.31	48.61	—	—	—	—
Uvarovite	32.05	21.00	—	—	—	—	—

* determined by X-ray powder diffraction method.

1 – Chrome garnets, Bandihalli, (Ananta Iyer and Kutty 1974).
2 – Chrome garnet of calc-silicate rock.
3 – Pyrope-almandine garnet of cordierite bearing rock.
4 – Salite of Calc-silicates.
5 – Calc-silicate rock.
6 – Cordierite bearing rock.
7 – Hornblendite.

When Cr_2O_3 *vs* Al_2O_3 of the available analyses of chrome grossular from the area, together with the green garnets of Canada (Dunn, 1978), are plotted, they show a negative linear variation (Fig. 3), which suggests that Al^{+3} has been replaced by Cr^{+3}. This indicates the possibility of having continuous solid solubility between grossularite and uvarovite end members.

The chemistry of the associated clinopyroxene corresponds to the composition of salite (Table I) with considerable amount of Al_2O_3 reflecting the original bulk chemistry of the host rock. The ultrabasic sill (Table 1 No. 7) found at the contact of the calc-silicate rock, contains Cr_2O_3 ($\sim$ 0.35%).

Figure 1. Calc-silicate band near Bandihalli, showing good foliation with steep dips.

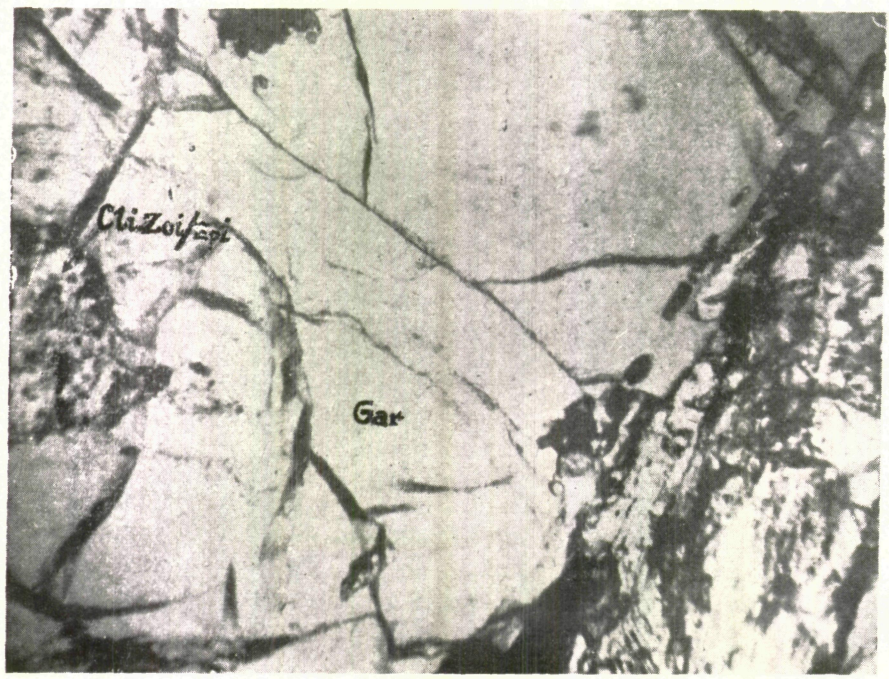

Figure 2. Photomicrograph of porphyroblastic green garnet with inclusions of altered clizoi/epidote aggregates.

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