GARNETS FROM WESTERN AUSTRALIAN KIMBERLITES AND ASSOCIATED ROCKS

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INTRODUCTION

This study is a survey of garnet chemistry from selected kimberlites, olivine lamproites and related rocks in Western Australia. Garnets were selected from heavy mineral concentrates, analysed, classified into Dawson and Stephens (1975) cluster groups (D & S Gp No. 1-12) and plotted on CaO vs Cr_2O_3 diagrams of Sobolev (1964) and Gurney (1984). Comparisons of the garnet types occurring in lamproite and kimberlite, diamondiferous and non-diamondiferous bodies, in different structural settings and of different intrusive ages, were made. The similarities of the Western Australian garnets with non-Australian kimberlite garnet analyses and their implications to the nature of the deep crust and mantle are discussed.

LOCALITIES STUDIED

West Kimberley: Ellendale Pipes

Three diamondiferous, olivine lamproite pipes, Ellendale 4, 7, and 9 were selected for study from the more than 100 Miocene intrusions in the West Kimberley province (Jaques et al 1984). The lamproites intrude the Lennard Shelf and adjacent Fitzroy basin where Upper Palaeozoic and early Mesozoic sediments overly deformed crystalline basement stablized around 1800 Ma ago. Megacryst minerals occurring with garnet include titaniferous magnesiochromite, chrome-diopside, olivine, orthopyroxene, rutile, corundum, kyanite, staurolite and andalusite. Ellendale 4 and 9 garnet is dominated by crustal almandine which is absent in Ellendale 7 and this probably reflects rock type variability in the crystalline basement. Most of the Ellendale chrome-pyrope analyses (D & S Gp 9) plot within the lherzolitic field of Sobolev (1964) but rare subcalcic chrome-pyrope (D & S Gp 10) was recovered from Ellendale 7 and 9. A wehrlitic garnet (D & S Gp 11) and titanian pyrope (D & S Gp 1 and 2) similar to megacrystal garnets (Nixon and Boyd 1973b) occur in Ellendale 7. Calcic pyrope-almandine (D & S Gp 3 and 6), with elevated Na_2O content suggestive of mantle eclogites, is also present.

East Kimberley: Maude Creek, Argyle, Bow Hill

The East Kimberley region contains kimberlites, lamproites and lamprophyres intruding the 1800 Ma cratonised Halls Creek Mobile Zone or the adjacent eastern margin of the Kimberley Block.

The Argyle olivine lamproite is a richly diamondiferous pipe which intrudes the Halls Creek Mobile Zone and is dated at 1200 Ma (Pidgeon et al, this volume). Macrocryst minerals are rare but magnesiochromite, garnet, chrome-diopside, orthopyroxene and magnesium-ilmenite have been recovered. Almandine of probable crustal origin is the dominant garnet. Of the rare pyropes present, chrome-pyrope is the most common. Titanian pyrope (D & S Gp 1) and calcic pyrope-almandine (D & S Gp 3) do occur but no subcalcic ones have been recovered.

The diamondiferous micaceous Maude Creek kimberlite dyke, with its abundant magnesium-ilmenite and pyrope garnet intrudes the eastern edge of the Kimberley Block. Titanian pyropes (D & S Gp 1 and 2) similar to the Lesotho megacrystal garnets (Nixon and Boyd, 1973b) predominate. Lherzolitic chrome-pyrope (D & S Gp 9 and 11) is also common and several subcalcic chrome-pyropes (D & S Gp 10) were recovered.

West of Argyle is Bow Hill, a non-diamondiferous lamprophyric dyke-swarm (Jaques and Fielding, this volume) intruding the Lower Proterozoic granites of the Halls Creek Mobile Zone and has been dated at 815 Ma (Pidgeon et al this volume). Macrocryst minerals include garnet, chrome-diopside, orthopyroxene and magnesiochromite.

Andradite with significant levels of TiO_2, Nb_2O_5 and ZrO_2 is the dominant garnet recovered. Chrome-bearing lherzolitic garnets (D & S Gp 9) and calcic pyrope-almandines (D & S Gp 3) of likely crustal origin are also present.

North Kimberley: Skerring and Hadfields Creek

The Skerring pipe 802 Ma (Pidgeon et al this volume) and Hadfields Creek dyke are non-diamondiferous, micaceous kimberlites intruding the north of Kimberley Block. The heavy mineral concentrates are characterized by coarse magnesium-ilmenite and pyrope. Skerring also contains subcalcic diopside, chrome-diopside, rutile, zircon and graphic intergrowths of silica with ilmenite. Titanian pyrope (D & S Gp 1 and 2), similar to Lesotho megacrystal garnets (Nixon and Boyd, 1973b), is the most common garnet type. Chrome-pyrope analyses from Skerring plot mostly within the lherzolitic field of Sobolev (1964) but the Hadfields Creek analyses are displaced into the wehrlitic field with increasing Cr_2O_3 content. A high-calcium chrome wehrlitic pyrope was recovered from Skerring. Rare subcalcic chrome-pyrope (D & S Gp 10) and few eclogitic garnets (D & S Gp 3 and 6) also occur.

Carnavon Basin: Wandagee

Intruding the Phanerozoic Carnavon Basin to the west of the Pilbara craton are 22 kimberlite-like diatremes, associated picrite sills and dykes (Kerr et al this volume) emplaced at about 160 Ma (Atkinson et al 1984). Two occurrences contain very rare microdiamonds. The macrocryst minerals in the concentrates usually include magnesiochromite, chrome-diopside, garnet, magnesium-ilmenite, magnetite, olivine and zircon. Crustal almandine is common. While chrome-bearing pyropes (D & S Gps 1, 9 and 11) are prevalent their analyses are displaced to higher levels in Sobolev (1964) lherzolitic field because of greater calcium contents.

CONCLUSIONS

Garnets from the selected Western Australian sources appear to be chemically similar to those from non-Australian kimberlites. This implies that similar chemical, pressure and temperature conditions prevail under stable cratons here, as for those elsewhere in the world. Peridotitic garnets (D & S Gps 1, 9 and 11) predominate over mantle derived eclogitic garnets (D & S Gp 3 and 6) in all occurrences studied. This contrasts to the garnet varieties occurring as inclusions in Argyle diamonds where eclogitic garnets are dominant and from Ellendale diamonds where eclogitic and peridotitic varieties occur in approximately equal proportions (Hall and Smith, 1984).

Western Australian kimberlites are characterised by abundant megacrystal, titanian pyrope (D & S Gp 1 and 2) which is rarely recovered from the lamproites. Subcalcic chrome-pyrope from the kimberlites and Ellendale lamproites suggests garnet harzburgite occurs as a widespread component of the mantle but the relative abundance of these garnets can not be related to the diamond content of the occurrences, for example non-diamondiferous Skerring contains subcalcic garnets. The relatively calcic peridotitic garnets from Wandagee support a more fertile mantle in the structurally "off craton" environment. The Bow Hill andradite garnet which is rare or unknown in kimberlites, suggests this lamprophyre may be related to alnoite or melilitite.

Variations in garnet composition within and between the studied occurrences support the vertical and horizontal heterogeneity of the mantle under north-western Australia.

REFERENCES

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