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Geochemistry of the Wyoming craton from eclogite xenoliths and garnet megacrysts from the Schaeffer and Aultman kimberlites

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The Colorado-Wyoming kimberlites within the Archaean Wyoming craton consists of more than 100 kimberlite intrusives [1]. Out of all major pipes and intrusives in the State Line the most economically promising are Sloan, Kelsey Lake and George Creek, with the rest having usually less than 1 ct/tonne of diamonds [2]. These kimberlites and the mantle below are poorly studied, with only a few studies addressing the petrology of mantle xenoliths and inclusions in diamonds.

Previous work has shown that mantle xenoliths are commonly eclogites, websterites and peridotites, with eclogites comprising around 35% of the recovered xenoliths [3]. Individual minerals were used to reconstruct the geotherm and yielded a wide range between ~37 and 45 mW/m^2 [4], with garnet megacrysts following the 40 mW/m^2 geotherm [5].

Here we investigate eight eclogite xenoliths and six garnet megacrysts from the previously not studied Schaffer Group and Aultman kimberlites. The pipes are located in the vicinity of the diamondiferous Kelsey lake kimberlites. Garnet megacrysts have 74-83 Mg# and contain between 4.5 and 5.1 wt% CaO and between 1.2 and 7.3 wt% Cr_2O_3. They also frequently have small Cr-spinel inclusions with 55-57 wt% Cr_2O_3.

Eclogitic garnet has <0.3 wt% Cr_2O_3, up to 11.4 wt% CaO and Mg# between 63 and 80. Clinopyroxene is typically diopsidic with Mg# between 83 and 96. In many samples we see the effect of secondary processes manifested by crystallisation of spongy clinopyroxene, surrounded by alkali-rich glass as well as veins and melt pockets filled with calcite, barite and other secondary minerals.

Estimates pressure-temperature conditions of xenoliths formation range between relatively shallow 2-2.5 GPa and 700-900^{o}C and deeper 3-4 GPa and 1000-1100^{o}C, falling between 40 and 45 mW/m^2 geotherms.

This indicates the lithospheric mantle beneath the Schaffer Group and Aultman kimberlites consists of a high proportion of eclogitic mantle, which consistent with inclusions in diamonds from nearby George Creek and Sloan kimberlites.

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