Insights into Mantle Geochemistry of Sc from the Main Carrier Minerals

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While many studies have routinely analyzed Sc concentrations in mantle rocks and minerals, this element has long been overlooked in most subsequent geochemical interpretations. Data mining of geochemical analyses on more than 11,000 garnets and 5,000 clinopyroxenes reveal that, below the spinel – garnet transition, the Sc budget of the mantle is controlled by Cr-pyrope garnet, while above it, clinopyroxene is the main carrier mineral (Fig. 1).

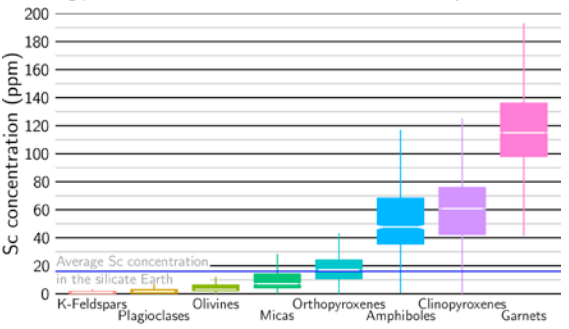

Figure 1: Boxplots of Sc concentrations in rock-forming minerals.

Those minerals also are key indicators of major processes operating in the mantle as their chemistry preserves a record of events, such as melt extraction and metasomatism. Thus, we have assessed the relative influence of crystal chemistry, modal mineral proportions and fluid-related events on the distribution of Sc in mantle garnets and clinopyroxenes to find clues on the geochemical budget of Sc in the mantle. We also focus on identifying the behavior of Sc relative to the transition elements and the rare earth elements, including Y, to improve the tracking of geochemical processes into the mantle.

We will show that the modal mineral proportions is the main factor influencing Sc distribution in garnets and clinopyroxenes with a strong effect of dilution in garnet- and clinopyroxene-rich rocks. But, for similar modal proportions, crystal chemistry is strongly affecting Sc concentration in garnets. It is of lesser importance in clinopyroxenes, where Sc distribution is sensitive to metasomatic events, in particular to carbonatite metasomatism. In regard with Cr-pyrope garnet geochemistry, Sc can be considered as behaving as a trivalent transition element while Sc behavior is close to the one of heavy rare earth elements in clinopyroxene.