# MINERALOGY AND GEOCHEMISTRY OF PEROVSKITE-RICH PYROXENITES.

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## PEROVSKITE PYROXENITES

Four carbonatite-pyroxenite complexes in the Eastern Periphery of the Paraná Basin, Brazil include units with ore grade accumulations of titanium in the form of anatase. The anatase is derived from the weathering of perovskite pyroxenites.

The circular structures of Catalão I, Serra Negra and Tapira contain perovskite pyroxenites as annuli located between central carbonatite cores and surrounding domed Precambrian sediments which are locally fenitized and silicified. Salitre I and II are satellites of the Serra Negra complex. Salitre I is oval-shaped and consists of pyroxenite and a small apatite carbonatite. Salitre II is a circular plug consisting predominantly of pyroxenite transected by thin carbonatite veins and lamprophyre (olivine phlogopitite) dikes.

In some areas of these complexes pyroxenite grades into glimmerite, and the presence of inclusions of apatite, calcite, magnetite and salite in phlogopite indicates the primary nature of the glimmerite. Magnetite and perovskite occur as cumulus aggregates, disseminations and bands that alternate with apatite, calcite and pyroxene layers. Apatite and magmatic calcite are always present.

The object of this study is to demonstrate that perovskite pyroxenites are early-formed members of this type of alkaline complex and to document the transformation of these rocks into supergene anatase ores.

## PYROXENES

Pyroxene compositional variation is of use in assessing the realtive degree of evolution of individual rock units within alkaline complexes. The typical evolutionary trend is one of iron enrichment. In all cases the most primitive compositions Similar pyroxene compositional trends are found in undersaturated and oversaturated complexes. Which trend is followed depends more on the peralkalinity and oxygen fugacity than the degree of silica saturation. Pyroxenes from the Brazilian perovskite pyroxenite complexes have diopside-salitic compositions with low acmite and hedenbergite contents. Many of the pyroxenes are pleochroic in shades of brown-green. Grain margins and areas adjacent to fractures and cleavages exhibit a stronger green pleochroism and are slightly richer in hedenbergite. Many pyroxenes contain sagenitic-textured magnetite inclusions. Pyroxenes from Salitre I are less evolved than those of Salitre II. Pyroxenes from Tapira and Iron Hill are the most evolved of those examined. All pyroxenes are however relatively unevolved compared to the overall pyroxene compositional trends. This observation demonstrates that perovskite pyroxenites must be early-formed members of this type of alkaline complex. Textural studies suggest that they represent cumulates and are unlikely to be metasomites.

## PEROVSKITES

Perovskite compositions reflect the degree of evolution of their host magma and the type of magma from which they crystallized. Early-formed perovskites are close to calcium titanate (perovskite end member) in composition. With evolution calcium may be replaced by Na, Sr and REE while Ti is replaced by Nb. Compositional evolution is thus typically from perovskite towards lueshite or loparite. Perovskites in the Brazilian and Afrikander perovskite pyroxenites follow the trend towards loparite. Early-formed perovskites are perovskite with low REE contents. These show textural evidence of reaction with late stage fluids leading to the development of REE enriched rims. In some cases mantles of loparite are developed upon cores of the less-evolved perovskite. Rare earth enrichment is related to the circulation of late-stage hydrothermal fluids. The perovskites in terms of their overall compositions are unevolved, confirming the conclusions derived from the pyroxene compositional trends that perovskite pyroxenites are unevolved members of these complexes. Significant Sr and Na enrichment does not occur in these perovskites and they thus differ from perovskites in carbonatites.

## ANATASE AND RHABDOPHANE

Perovskite pyroxenites are an important source of Ti where intense lateritic weathering has led to decalcification of perovskite. In the Brazilian complexes anatase is concentrated in the zone of weathering. At deeper levels residual cores of perovskite are found within anatase grains. Below the zone of weathering only fresh perovskite is found. Electron microscopy shows that the anatase displays a platy habit. Aggregations of plates commonly form rosettes. The altered rocks are very porous as all of the components of the pyroxenes and micas originally present were removed during the laterization process. Solutions percolating through the anatase matrix typically precipitate microcrystalline aggregates of rhabdophane cerianite, monazite and crandalite-group minerals. The rare earths are derived primarily from the decomposed perovskite, and the phosphate from apatite.

## MICAS

The compositions of micas parallel those of pyroxenes in showing the relative degree of evolution of the pyroxenites. Rocks from Tapira are the most-evolved and those from Salitre I the least-evolved. Micas within each complex are zoned and exhibit a trend of decreasing alumina from core to margin. This trend represents evolution from phlogopite towards tetraferriphlogopite.

## OLIVINES

Olivines in associated perovskite olivinites are magnesian and unevolved. At Salitre I they contain from 10-12 wt.% FeO and have negligible CaO (< 0.3 wt.%) and MnO contents (< 0.5 wt.%). Salitre II olivines range in FeO content from 8-15 wt.%.