The Origin of Fumarolitic Andradite at Menoyre, France and Fant’Ale, Ethiopia

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Abstract. Recent discoveries of fumarolitic andradite in alkaline or peralkaline trachytes (Menoyre, Cantal, France, and Fant’Ale, Ethiopia) are interpreted genetically. The andradites were formed from the constituents of pyroxene, always calcic and iron-rich in these rocks. The elements Ca and Fe were fixed on the surface of fractures by late fumaroles of high oxidizing capacity.

The following reaction can be established at Menoyre:

hedenbergite + O₂ → andradite + hematite + cristobalite.

In a hyperalkaline medium, which is the case for the trachyte of Fant’Ale, the reaction is:

Hedenbergite + sodium metasilicate + O₂ → andradite + aegirine pyroxene + cristobalite.

Introduction

Fumarolitic garnets developed on the fracture surfaces of two trachytic massifs at Menoyre, Cantal, France and at Fant’Ale, Ethiopia, have already been described (Varet, 1967, 1969a). In both examples, the minerals belong to a late crystallization which occurred after the solidification of a viscous lava dome (Fig. 1). These minerals are not found in the rock, but are always located on fracture surfaces or, as at Menoyre, also in cavities near these areas (Fig. 2). Their origin is due to the circulation, at near atmospheric pressure, of high-temperature fumaroles (above 700°C) in these fractures, probably during the cooling of the dome.

These conclusions (Varet, 1967) are deduced from the mineralogical association (hematite + andradite) found in the cavities of the trachyte of Menoyre, and from the location of the garnets.

The origin of the elements constituting these andradites (analyses given on Table 1) remained to be determined. Even though silica in the saturated trachytes is free, probably not all calcium, iron, titanium and manganese were brought in by the fumaroles; their origin must be sought in situ.

Recent work by Huckenholz (1969a) has drawn attention to the transformation of calcic clinopyroxene into andradite according to the following reaction:

\[ \text{calcic clinopyroxene} + O_2 \rightarrow \text{ferridioipside} + \text{andradite} + \text{quartz} \] (1)

We are here concerned with further study of the relations between andradites and the ferromagnesian minerals of the trachytes.
Fig. 1. Andradite crystals developed on a fracture shelf of the dome at Menoyre. Note the lineations contemporaneous with the solidification of the dome, and the later garnets surrounding these structures.

Fig. 2. Andradite crystal in cavities in the trachytic dome at Menoyre. Note the association andradite + hematite in the cavities, and the lighter-coloured trachyte in contact with the garnets (approximately 1 cm).