Petrology and mineralogy of wollastonite- and melilite-bearing paralavas from the Central Apennines, Italy

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ABSTRACT

Small outcrops of wollastonite- and melilite-bearing pyrometamorphic rocks (paralavas) are found along the Apennine chain in Central Italy at the localities of Colle Fabbri and Ricetto. These rocks have coarse- to fine-grained crystalline, spotted, and glassy textures. The Colle Fabbri rocks have abundant and ubiquitous wollastonite, with plagioclase ± clinopyroxene. Melilite is found only in the most Ca-rich and silica-poor samples. Garnet, perovskite, quartz, leucite, silica-rich glassy mesostasis, and ocelli filled by calcite are present locally. The Ricetto rock is made up of wollastonite and melilite with minor clinopyroxene set in a glassy matrix with a few crystals of restitic quartz. These rocks have variable contents of SiO₂ (43 to 64 wt%) and CaO (37 to 3.7 wt%). The latter decreases with increasing MgO, Al₂O₃, Fe₂O₃ tot, TiO₂, K₂O, SiO₂, and most trace elements, excluding Sr. Peculiar parageneses (e.g., coexisting melilite and anorthite in the most silica-poor samples, abundance of wollastonite), mineral compositions (gehlenite-rich melilite; Al-, Ti-, and Fe³⁺-rich clinopyroxene; Al-, Ti-rich, but Fe-poor garnet), and major- and trace-element geochemistry suggest that the Colle Fabbri and Ricetto rocks are not ultimately mantle-derived, but are the result of melting, devolatilization, and recrystallization of marly sediments (50–60 to 5–10% calcite, with clay minerals ± quartz), likely due to coal fires. The ⁸⁷Sr/⁸⁶Sr and ¹⁴³Nd/¹⁴⁴Nd range from 0.70772 to 0.71190 and from 0.51223 to 0.51219, respectively, again suggesting sedimentary protoliths of a mixed nature. Substantial chemical and isotopic differences between these samples and those from the Roman Magmatic Province are highlighted.

INTRODUCTION

Melilite-bearing rocks are found in magmatic and metamorphic environments. Their presence in magmatic environments is important to better understand the genesis of strongly alkaline, silica-poor magmas (e.g., Dunworth and Wilson 1998 and references therein), whereas in metamorphic environments, melilite-bearing rocks are indicative of high temperature, and derive from high-Ca protoliths, such as impure limestones or marls. In some cases, metasomatic interaction between basaltic magma and limestone produced melilitic-plagioclase-bearing rocks (e.g., Scawt Hill, Northern Ireland: Tilley and Harwood 1931; Yoder 1973). Melilite-bearing rocks are also known to be the result of pyrometamorphism, triggered by coal fires, with formation of paralavas and bouchites (Bentor et al. 1981; Cosca and Peacor 1987; Foit et al. 1987; Cosca et al. 1989; Clark and Peacor 1992).

Melilite-bearing volcanic rocks are well known in Italy (e.g., Conticelli and Peccerillo 1992; Melluso et al. 1996; Di Battistini et al. 2001 and references therein), and are found in several volcanic districts belonging to the Plio-Pleistocene potassic and ultrapotassic magmatic province (San Venanzo, Vulsini, Cupaello, Alban Hills, Ernici, Mount Vulture). They have been variably interpreted either as mantle-derived magmatic products or the result of interaction between mafic potassic magmas and carbonate-rich sedimentary rocks (e.g., limestone, marls; Peccerillo 1998, and references therein).

Small outcrops of melilite-bearing rocks with slag morphology, from a few decimeters to some meters wide, are found at Colle Fabbri and Ricetto, Central Apennines (Bellotti et al. 1987; Stoppa 1988). The published chemical analyses of the whole rocks and their mineralogy are uncommon for magmatic, ultimately mantle-derived rocks. In the present paper, mineralogical, chemical, and isotopic data are reported and discussed, to elucidate the possible origin of the melilite- and wollastonite-bearing rocks from Colle Fabbri and Ricetto in the framework of magmatic or pyrometamorphic processes.

GEOLOGICAL SETTING

The Colle Fabbri body is located close to the town of Spoleto (Fig. 1). Upper Miocene marls and sandstones (“Marnoso-Arenacea” Formation) and Villafranchian (Late Pliocene–Early Pleistocene) siltstones and claystones are the main country