C. R. Geoscience xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Comptes Rendus Geoscience

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Petrology, Geochemistry (Geochronology)

New $^{40}Ar/^{39}Ar$ constraints for the "Grande Nappe": The largest rhyolitic eruption from the Mont-Dore Massif (French Massif Central)

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ARTICLE INFO

Article history:
Received 19 January 2017
Accepted after revision 9 February 2017
Available online xxx

Handled by Marc Chaussidon

Keywords:
Mont-Dore Massif
Grande Nappe
$^{40}Ar/^{39}Ar$
Xenocrysts contamination
Haute-Dordogne caldera
France

ABSTRACT

Since the 1960s, an early explosive activity in the Mont-Dore Massif is associated with a major pyroclastic rhyolitic eruption (5–7 km^3) known as the "Grande Nappe" (GN). This event, linked to the formation of a 6-km-diameter cryptic caldera named "Haute Dordogne", was before our investigation dated by $^{40}Ar/^{39}Ar$ at 3.07 ± 0.04 Ma. Our new single-crystal laser fusion $^{40}Ar/^{39}Ar$ dates obtained on two outcrops of the GN (Rochefort-Montagne and Ludières) questioned several hypotheses made concerning this "landmark" event of the Mont-Dore Massif history. We demonstrate that: (1) the GN rhyolitic eruption has occurred much later than previously estimated (*i.e.* 2.77 ± 0.02–0.07 Ma full external uncertainties); (2) the correlation made between the Vendeix rhyolitic complexes (intra-caldera position) dated back to 2.74 ± 0.04 Ma and the GN is proposed; (3) xenocryst contamination could be very high (*i.e.* 70% for the Rochefort-Montagne GN outcrop) and explains the noticeable older age obtained previously; (4) a link between the GN eruption and the formation of a caldera is questionable; the hypothesis of a northward-oriented blast channeled eastward toward the paleo-Allier River is thus proposed.

1. Introduction

Two large stratovolcanoes are known in the French Massif Central: the Cantal and the Mont-Dore Massif (Fig. 1). The youngest of these edifices (Mont-Dore) covers an area of 500 km^2 and rests on the Variscan basement (Cantagrel and Baubron, 1983). The total volume erupted from the Mont-Dore Massif has been estimated between 220 km^3 and 70 km^3 (Brousse, 1971; Cantagrel and Baubron, 1983; Cantagrel and Briot, 1990; Vincent, 1980; Fig. 1). This massif is composed of two coalescent stratovolcanoes: the Guéry and the Sancy (Cantagrel and Baubron, 1983; Nomade et al., 2014a; Pastre and Cantagrel, 2001). The diversity and the wide dispersion of its

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http://dx.doi.org/10.1016/j.crte.2017.02.003

Please cite this article in press as: Nomade S, et al. New $^{40}Ar/^{39}Ar$ constraints for the "Grande Nappe": The largest rhyolitic eruption from the Mont-Dore Massif (French Massif Central). C. R. Geoscience (2017), http://dx.doi.org/10.1016/j.crte.2017.02.003

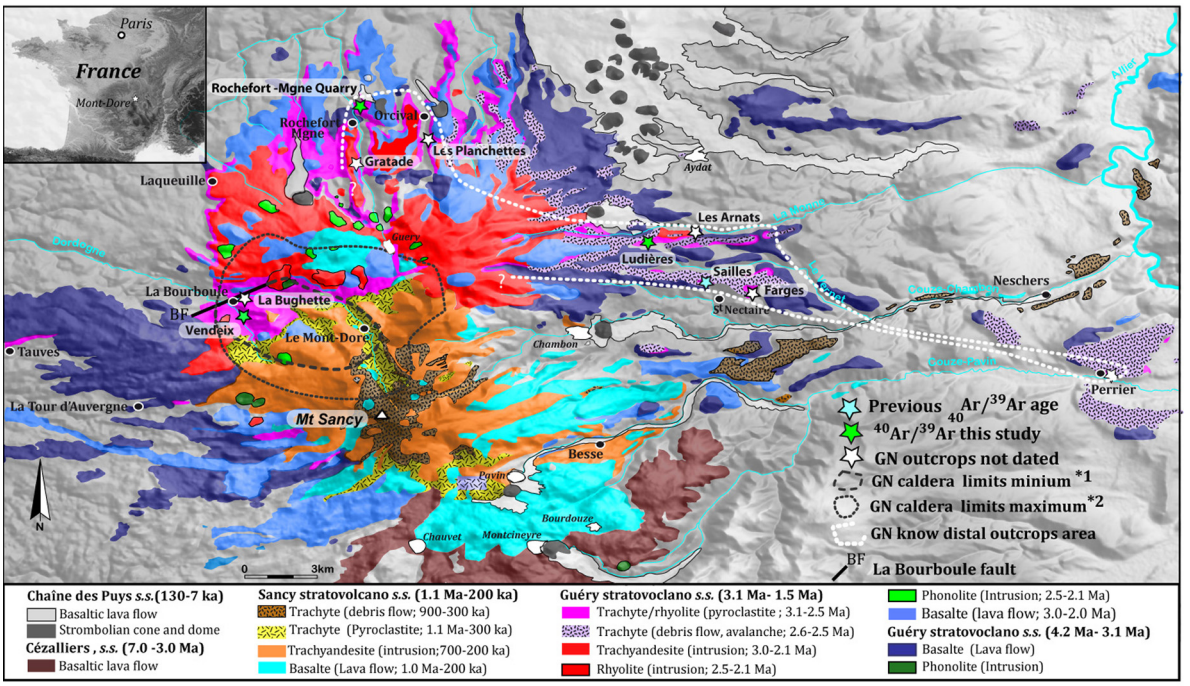

Fig. 1. Mont-Dore Massif synthetic geological map and sampling location (modified from Cantagrel and Baubron, 1983). The Mont-Dore Massif is constituted by the Sancy and Guéry stratovolcanoes (Pastre and Cantagrel, 2001). The lower and upper extension limits of the GN caldera are from Mossand et al. (1982) and Varet et al. (1980), respectively.

pyroclastic products have been used for stratigraphic correlation and dating of the Plio-Pleistocene formations in the French Massif Central and elsewhere (Degeai et al., 2013; Nomade et al., 2010; Pastre and Cantagrel, 2001; Pastre et al., 2015). Several recent $^{40}Ar/^{39}Ar$ investigations have allowed refining the history of the Mont-Dore Massif explosive activity (Nomade et al., 2012, 2014a,b). These new chronological constraints have highlighted that the pyroclastic activity of the massif was more complex that previously thought and comprised of eight cycles (3.1 Ma to 300 ka) lasting about 100 ka each (Nomade et al., 2014a). Despite these recent efforts, several questions remain open, in particular among the early explosive activity of the Guéry stratovolcano (cycle G.I and G.II in Nomade et al., 2014a). The accurate age, the volume and the origin of the iconic rhyolitic eruption known as the "Grande Nappe" (GN hereafter; Vincent, 1979; 1980) remain elusive, mainly because of the lack of single crystal $^{40}Ar/^{39}Ar$ investigation.

2. The "Grande Nappe": geological background and current age constraints

The term "Grande Nappe", created by Vincent (1979, 1980), designates the main pyroclastic formation of Mont-Dore with a rhyolitic composition. This "eruption" is also known under different names: "nappe supérieure" (Brousse, 1963), "nappe rhyolitique", "nappe de Rochefort" and "nappe of Sailles" (Besson, 1978), "nappe externe" (Brousse, 1984), or Mont-Dore ignimbrite (Pastre and Cantagrel, 2001). According to the original suggestion of Vincent (1979), the GN includes under this general name all rhyolitic products found under "the intermediate complex" defined by this author and the "upper pumice stones" found in the external flanks of the Mont-Dore. The formation of this GN is suggested to be linked to the formation of a cryptic caldera named C1 or "Haute-Dordogne" (Vincent, 1979, 1980). The limit of this caldera remains unclear as traces of this depression are probably buried below more recent products. From a chronological point of view, we now know that in the internal part of the Guéry stratovolcano the "upper pumice stones" correspond in reality to several trachytic pyroclastic units emplaced in two phases (G.II: 2.73–2.60 Ma and G.III: 2.40–1.95 Ma) as well as to the younger Sancy stratovolcano starting to erupt much later, at about 1.1 Ma (C.I.) (Nomade et al., 2012, 2014a). Therefore, the GN is by definition older than 2.73 ± 0.02 Ma, which is the age of the oldest trachytic pyroclastic rock located above the GN (La Bourboule Haut, Nomade et al., 2014a). The current age of the GN (*i.e.* 3.07 ± 0.04 Ma (2σ uncertainty), Féraud et al., 1990; Fig. 1) corresponds to the weighted mean of three independent ages (*i.e.* sanidine populations including 5–7 crystals) coming from a single outcrop (*i.e.* Sailles). Because of the ubiquist xenocrystic contamination of the Guéry pyroclastic products shown in Nomade et al. (2014a), the accuracy of this age could legitimately be questioned.

Historically, the GN outcrops were divided into two groups: proximal/internal or distal/external deposits corresponding to outcrops found inside (*e.g.*, Brousse, 1963; Brousse and Lefèvre, 1966; Ménard, 1979; Pastre, 1987; Pastre and Cantagrel, 2001; Vincent, 1979, 1980)

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