Volatile-rich melts as markers of the asthenospheric influx prior to rifting events: the case of the alkaline-carbonatitic lamprophyres of the Dolomitic Area (Southern Alps, Italy)

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The lamprophyric dykes
Alkaline lamprophyres intruded in the Middle Triassic (237-238 Ma; Storck et al., 2019; 2020) Predazzo Intrusive Complex (see also Casetta et al., 2018a; 2018b), the overlying volcanites and the Permo-Triassic sedimentary host rocks (see Abbas et al., 2018)

- Greenish colour
- Thickness 0.2-2.0 m
- WNW-ESE to N-S orientation
- Intense state of alteration

Main questions
- Relationships between lamprophyres and the host Middle Triassic rocks (242.01±0.05 to 237.58±0.04 Ma; Storck et al., 2019; 2020) with orogenic-like affinity
- Petrological/geochemical evolution of the magmatism in the Dolomitic Area during Triassic

From Casetta et al. (2019)
Similar to worldwide AL (Rock, 1991); $\text{Al}_2\text{O}_3$-enriched with respect to the Cretaceous (110 Ma) to Oligocene (29 Ma) Italian lamprophyres (Stoppa et al., 2014)

Panidiomorphic texture: amphibole 35-55 vol.%, plagioclase 30-40 vol.%, clinopyroxene 0-10 vol.%, olivine 0-10 vol.%, K-feldspar 2-6 vol.%, Fe-Ti oxides 3-6 vol.%. Accessory phases: ilmenite, titanite, apatite, analcime

Classification: **Camptonites** (Le Maitre et al., 2002)

From Casetta et al. (2019)
• Nb-Ta-Zr-Ti and LILE enrichments; Th-U negative anomalies

• LREE enrichment; flat M-HREE profiles; absence of Eu negative anomaly

• Generally depleted with respect to worldwide camptonites and the other Italian lamprophyres

From Casetta et al. (2019)
Carbonate ocelli

- Spherical shape, easily distinguishable from secondary-filled amygdalae
- Flow-aligned tangential growth of high-temperature-forming silicates (Pl, Amp, Cpx)
- Lack of more typically hydrothermal minerals, such as zeolites
- Absence of positive correlation between CaO/MgO and SrO + MnO for dolomite-ankerite crystals

From Casetta et al. (2019)

Magnesite-siderite: low-\(T\) precipitation
Dolomite-ankerite: high-\(T\) origin

Droplets of carbonatitic-like melt coexisting with the silicatic one
Amphibole separates:
Plateau age = $219.70 \pm 0.73/0.85$ Ma

Plagioclase separates:
Plateau age = $218.90 \pm 0.59/0.66$ Ma

- Predazzo lamprophyres emplaced at $218.5$-$220.5$ Ma, about 20 Ma later than the shoshonitic magmatic event ($238.19 \pm 0.05$ to $237.58 \pm 0.04$ Ma; Storck et al., 2019; 2020)

- Sr-Nd isotopes: lamprophyres mantle source more depleted than the one that generated shoshonitic magmas (Predazzo Intrusive Complex; Casetta et al., 2018a)
Coeval magmatism

**Brescian Alps:** 217±3 Ma intra-plate tholeiites, precursor of the Tethyan opening (Cassinis et al., 2008)

**Ditrua alkaline massif (Carpathians):** < 227 Ma; late-stage alkaline lamprophyres intruded in a Middle-Triassic pluton; early stage related to the Alpine Tethys rifting northward of the Meliata basin? (Dallmeyer et al., 1997; Morogan et al., 2000; Stampfli et al., 2002; Stampfli, 2005; Batki et al., 2014; Pál-Molnár et al., 2015)

**Ivrea Zone, Western Alps:** 190-212.5 to 225±13 Ma alkaline dykes intruded in the Finero peridotite; upwelling mantle with asthenospheric contribution? (Stähle et al., 1990; 2001; Schaltegger et al., 2015)

**Ivrea Zone, Western Alps:** 215±35 Ma to 220±4 Ma metasomatic apatite-rich and chromitite layers in the Finero peridotite; unique alkaline-carbonatitic magmatic event generated by mantle upwelling dynamics in a continental rifting setting? (Zaccarini et al., 2004; Morishita et al., 2008; Malitch et al., 2017)

**Ivrea Zone, Western Alps:** 185-195 Ma alkaline-carbonatitic bodies; nascent passive margin of Adria during the Early Jurassic breakup of Pangea? (Galli et al., 2019)
Conclusions

**Lamprophyres (218.5-220.5 Ma)** are unrelated to the short-lived Middle Triassic orogenic-like magmatism of the Dolomites. Their trace element and Sr-Nd isotopic distribution record a significant *asthenospheric* contribution.

Genesis: **1.0-2.5%** melting of a fertile *garnet-amphibole-bearing lherzolite* (70-80 km depth?)

Carbonate ocelli: *carbonatitic melt* intimately associated to the alkaline lamprophyric one?

Lamprophyres belong to the **alkaline-carbonatitic pulse** that infiltrated several portions of the Southern Alps SCLM during Late Triassic.

Lamprophyres are markers of the **shift** from orogenic-like to anorogenic magmatism in the Southern Alps, where the mantle source was progressively being depleted by an asthenospheric influx related to the **Alpine Tethys opening**.

Deep and volatiles (H₂O-CO₂)-rich pulses generated by lithosphere-asthenosphere interactions prior to a major rifting event.
Thank you for your attention