EGU General Assembly 2020

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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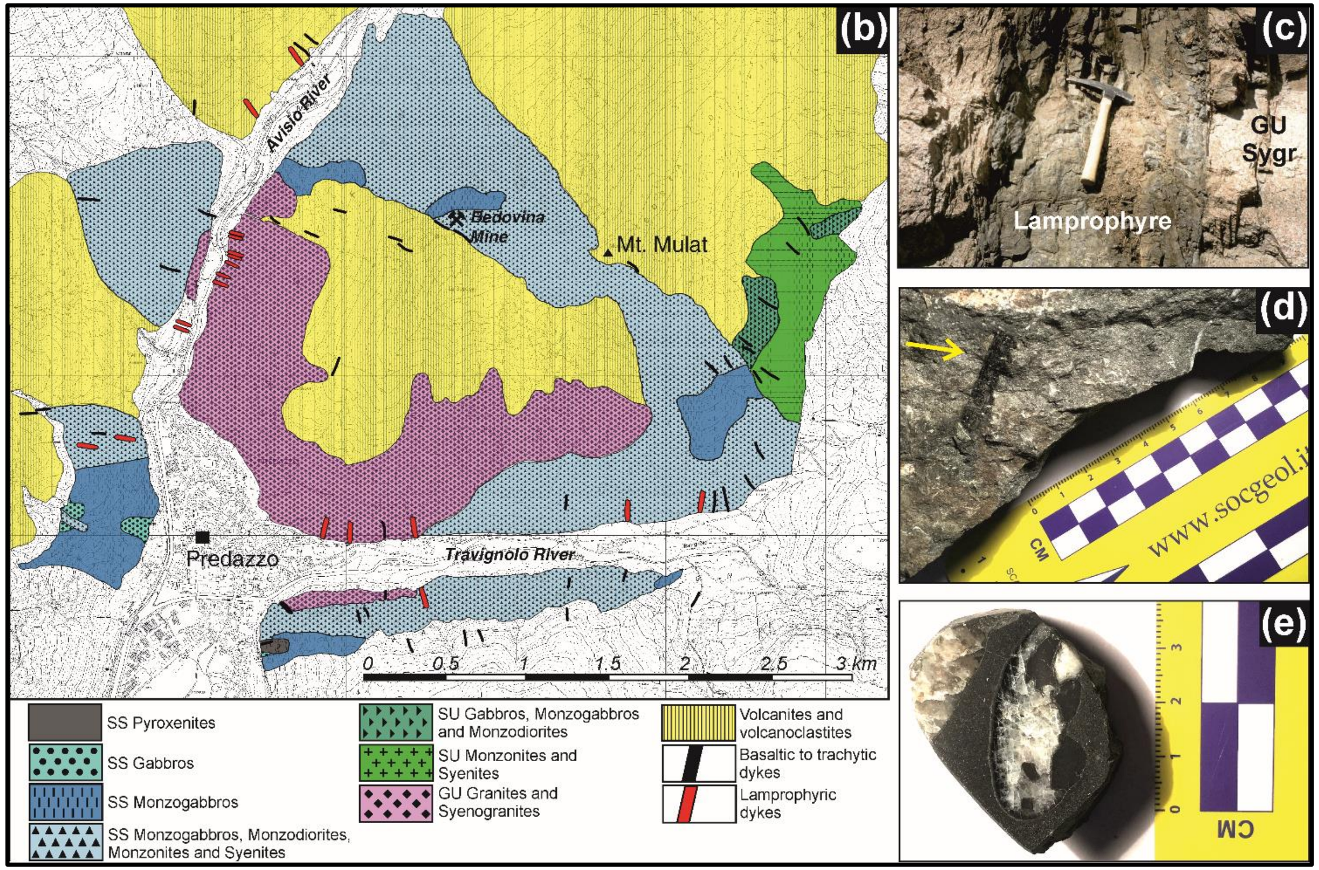
The lamprophyric dykes

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

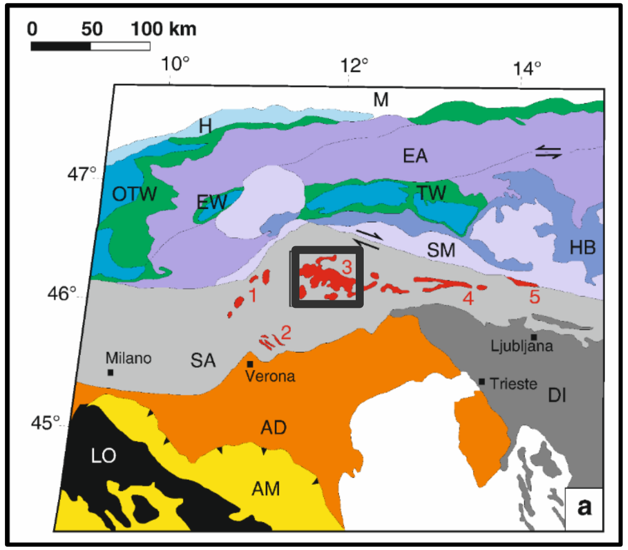


From Casetta et al. (2019)

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

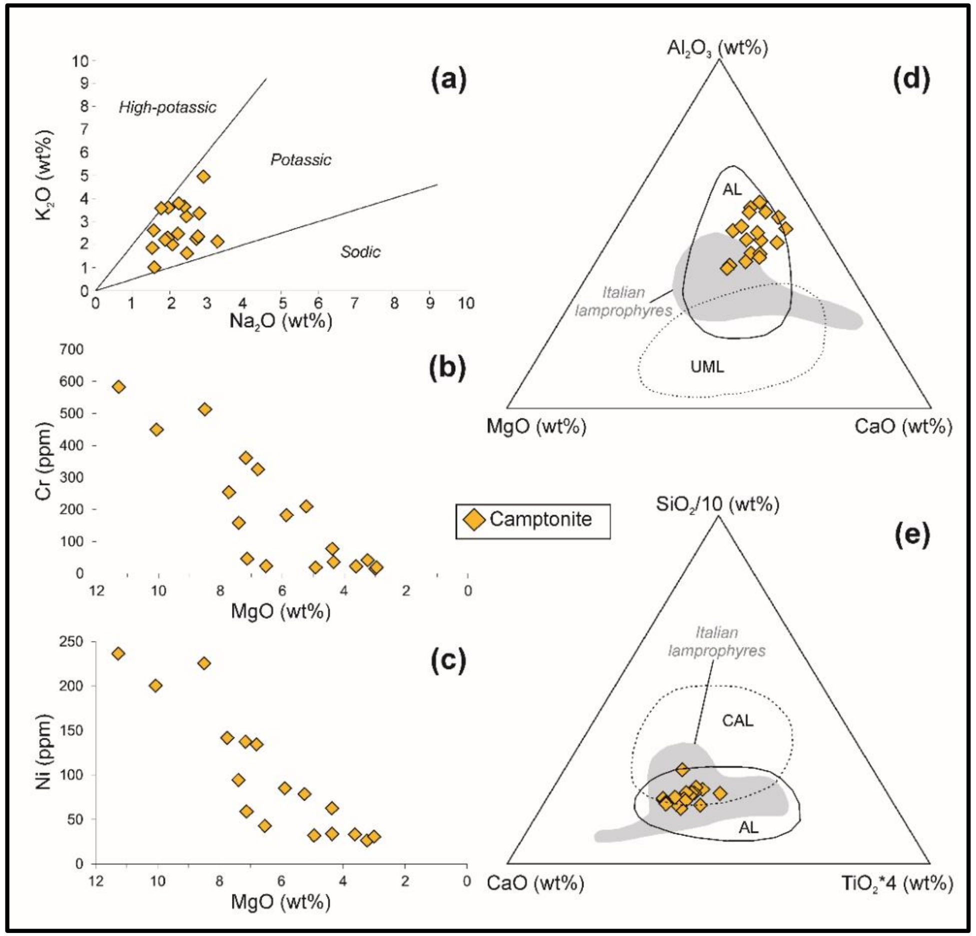


Modified from Dal Piaz et al. (2003) and Schmid et al. (2016)

Introduction and state of art

Petrography + WR geochemistry

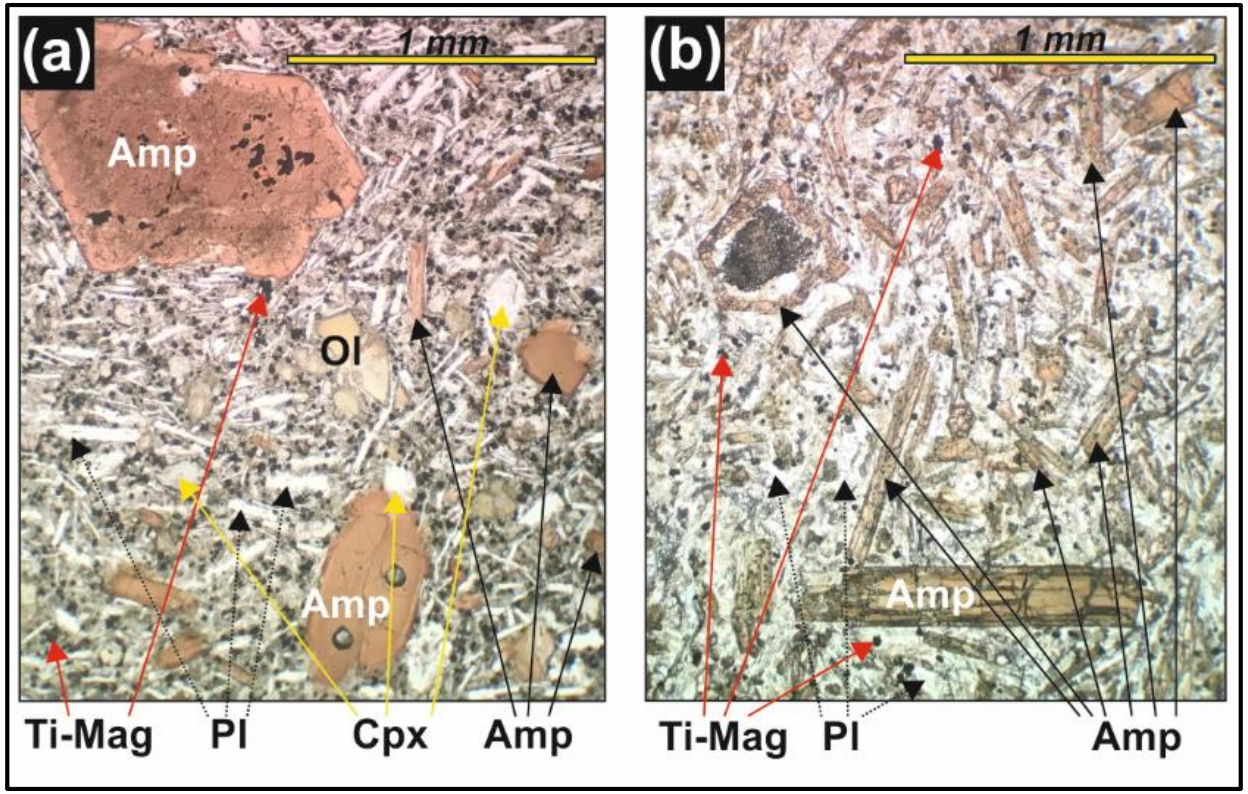
Similar to worldwide AL (*Rock, 1991*); Al_2O_3-enriched with respect to the Cretaceous (110 Ma) to Oligocene (29 Ma) Italian lamprophyres (*Stoppa et al., 2014*)



From Casetta et al. (2019)

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

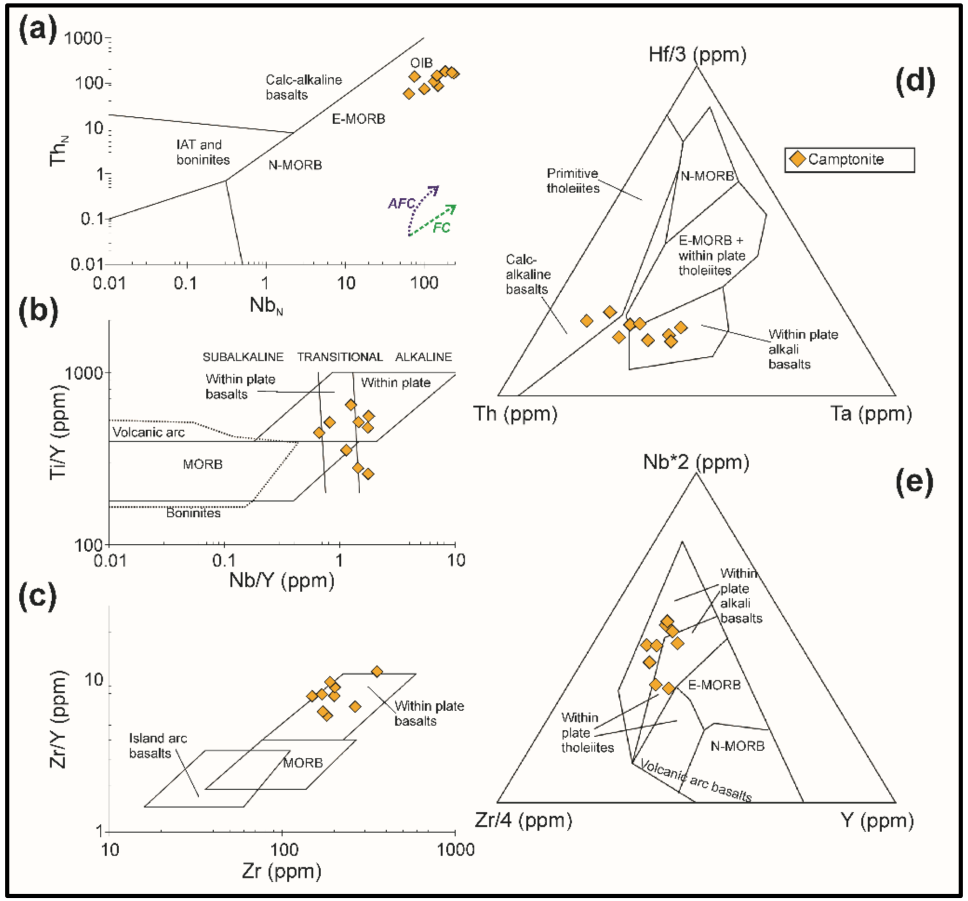
Classification: **Camptonites** (*Le Maitre et al., 2002*)



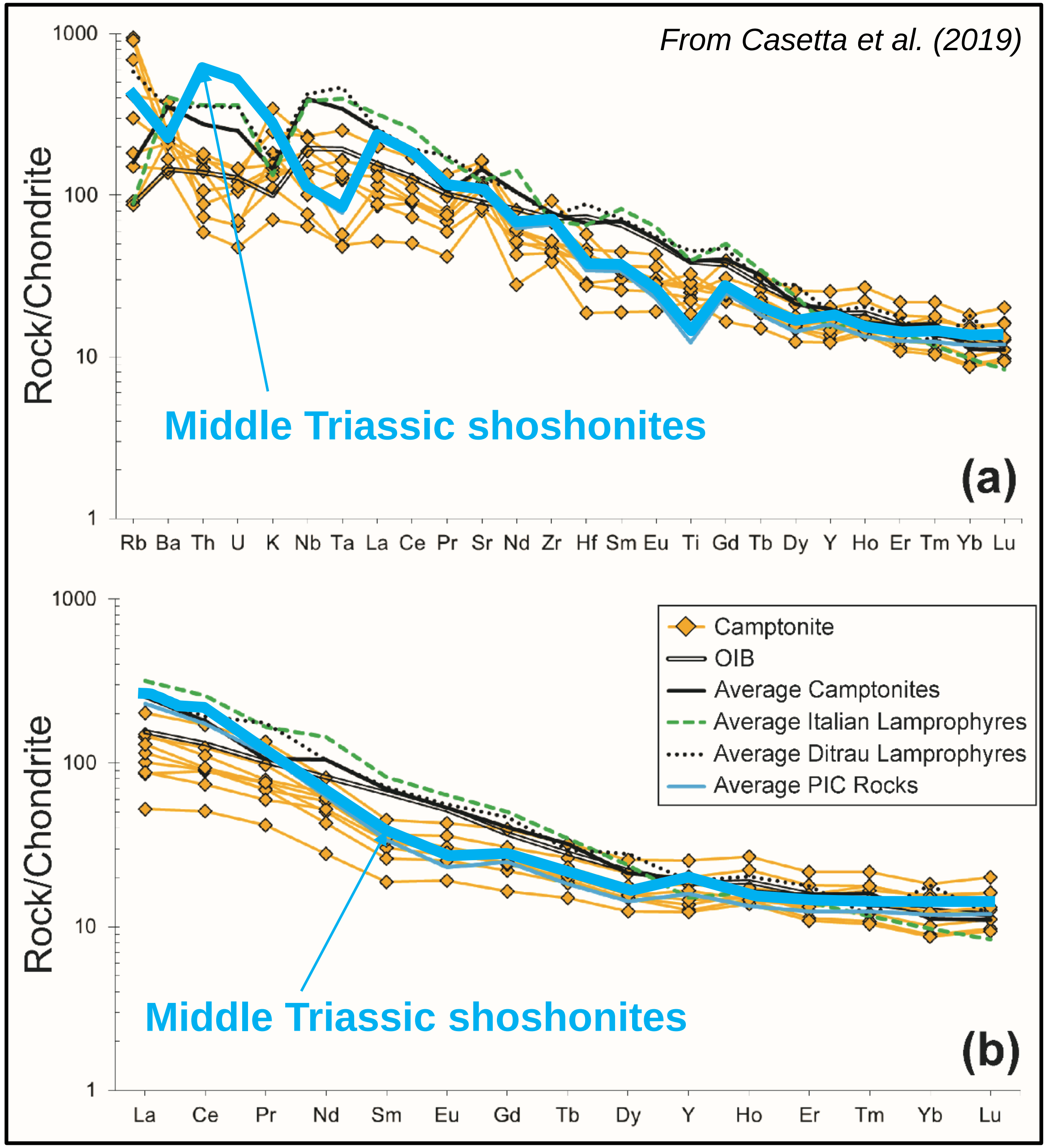
From Casetta et al. (2019)

WR geochemistry

- 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

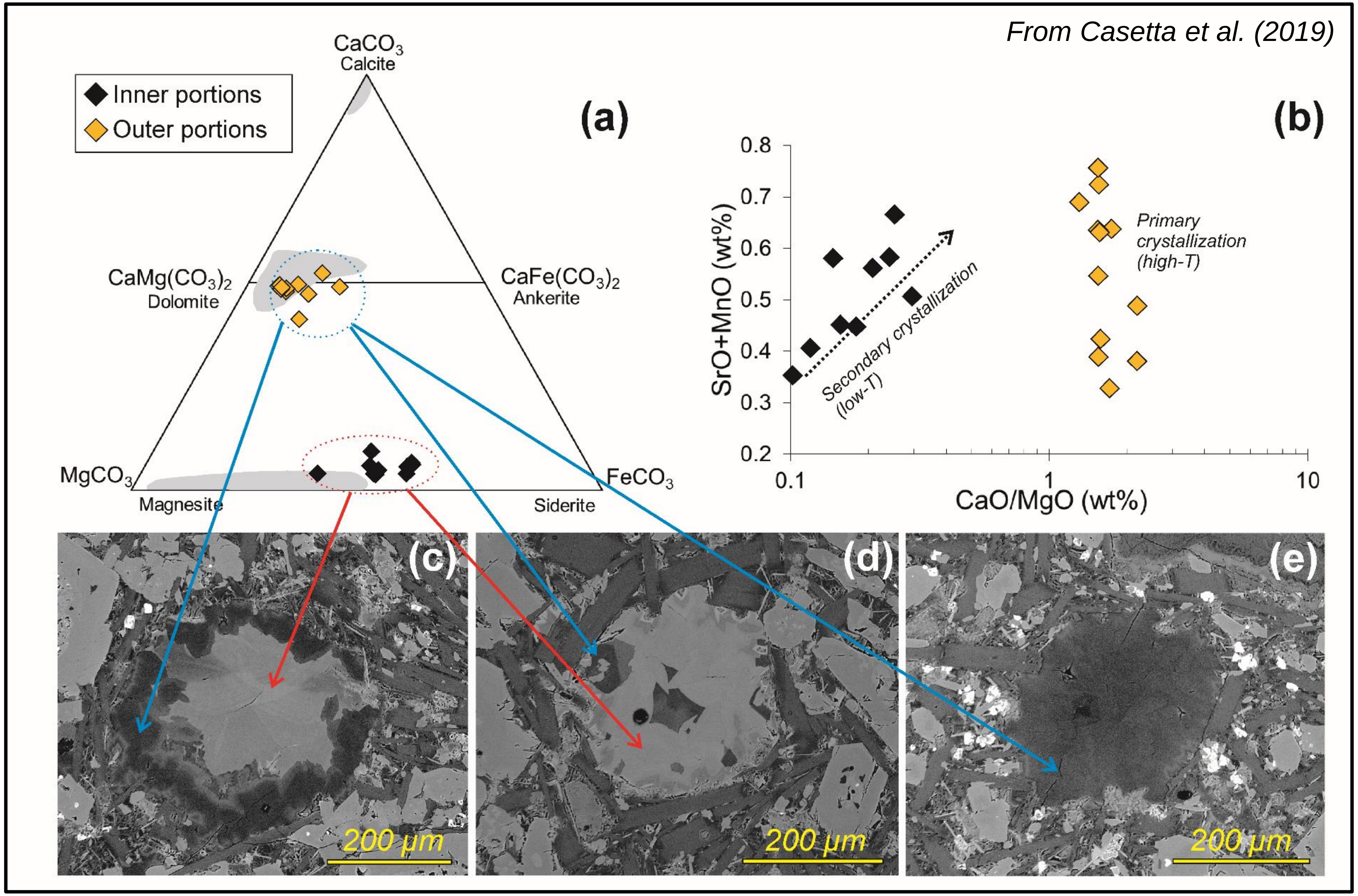


From Casetta et al. (2019)



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



Magnesite-siderite: **low-*T*** precipitation

Dolomite-ankerite: **high-*T*** origin

Droplets of carbonatitic-like melt coexisting with the silicatic one

Carbonate ocelli

Age and Sr-Nd isotopes

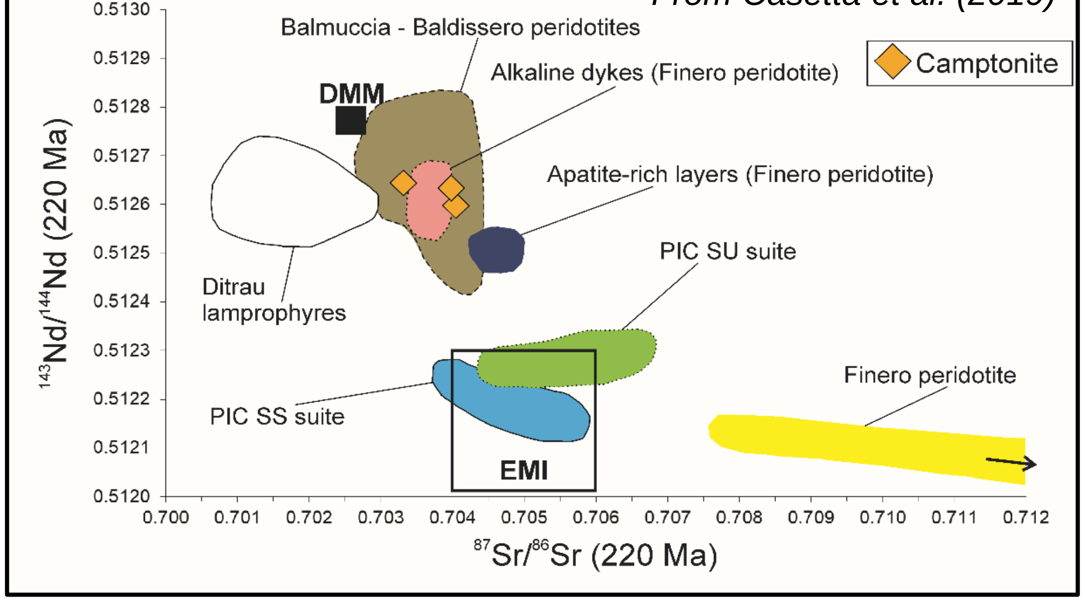
Amphibole separates:
Plateau age = **219.70 ± 0.73/0.85 Ma**

Plagioclase separates:
Plateau age = **218.90 ± 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±0.05 to 237.58±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)

From Casetta et al. (2019)



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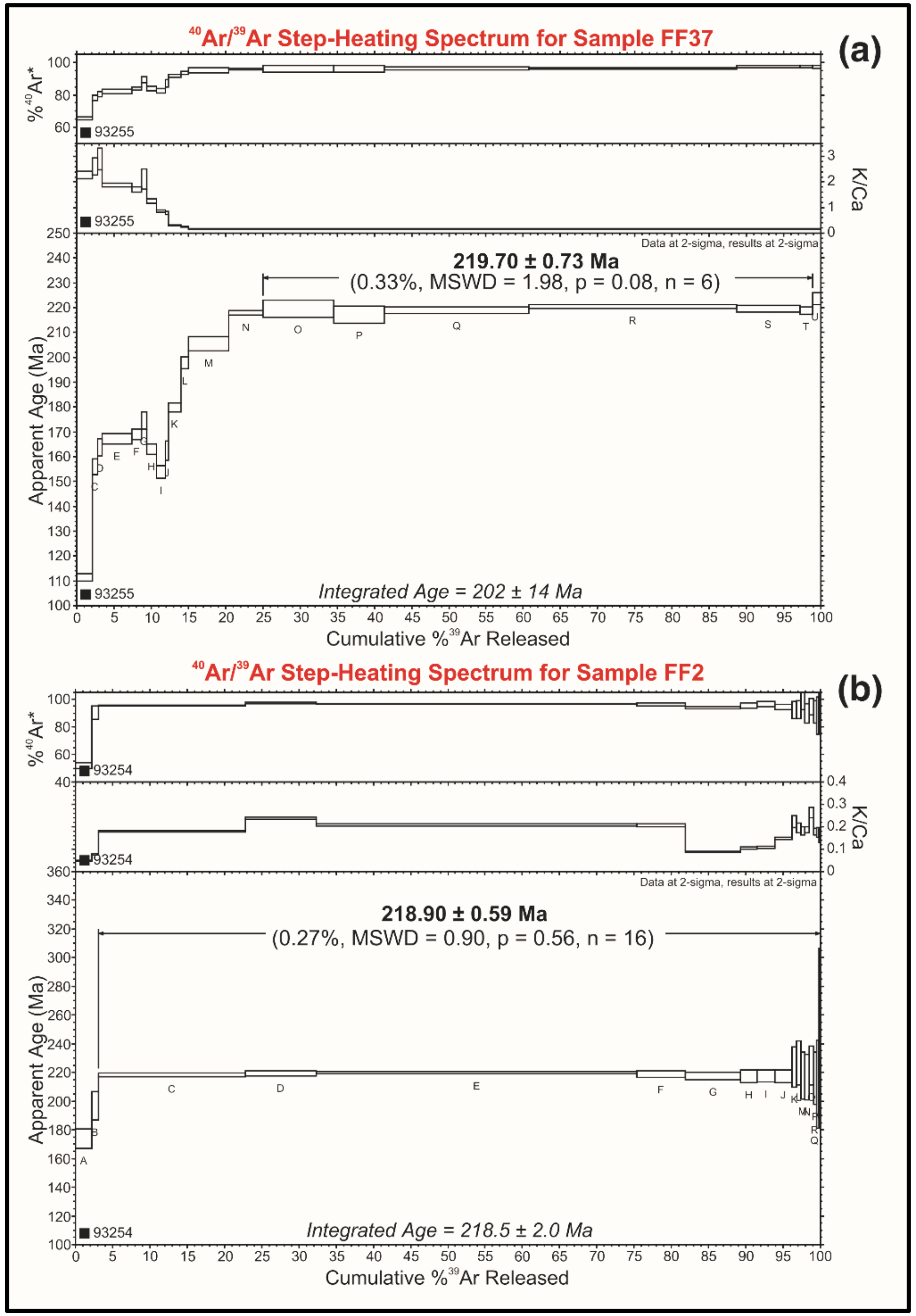

Coeval magmatism

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

Ditrau 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 (H_2O-CO_2)-rich pulses generated by lithosphere-asthenosphere interactions prior to a major rifting event

Thank you for your attention

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