What olivine and clinopyroxene mineral chemistry and melt inclusion study can tell us about magmatic processes in a post-collisional setting. Examples from the Miocene-Quaternary East Carpathian volcanic chain, Romania

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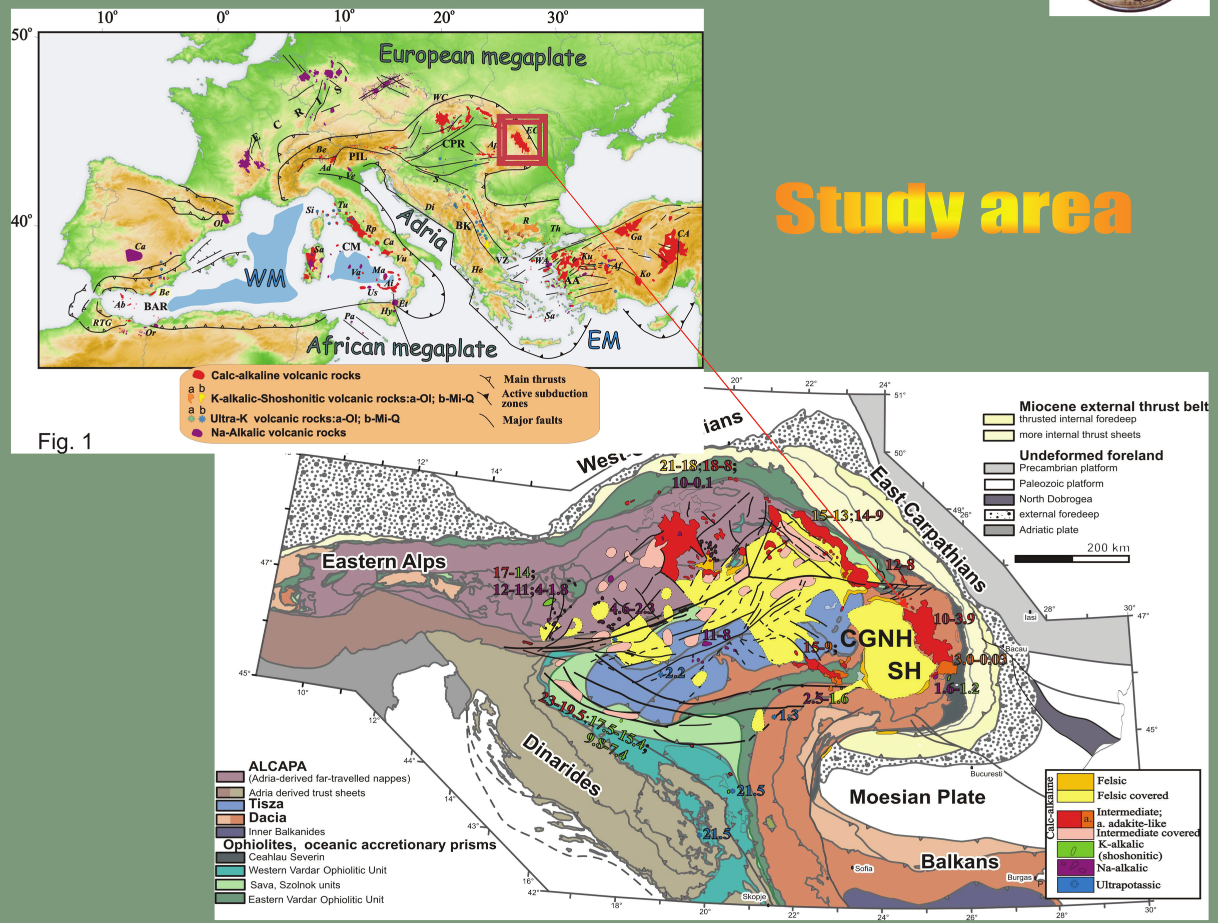
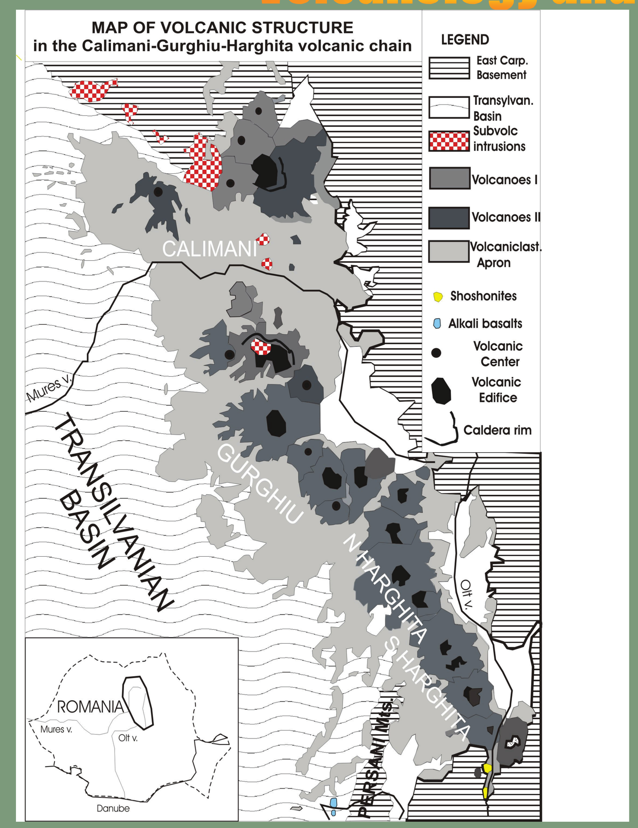
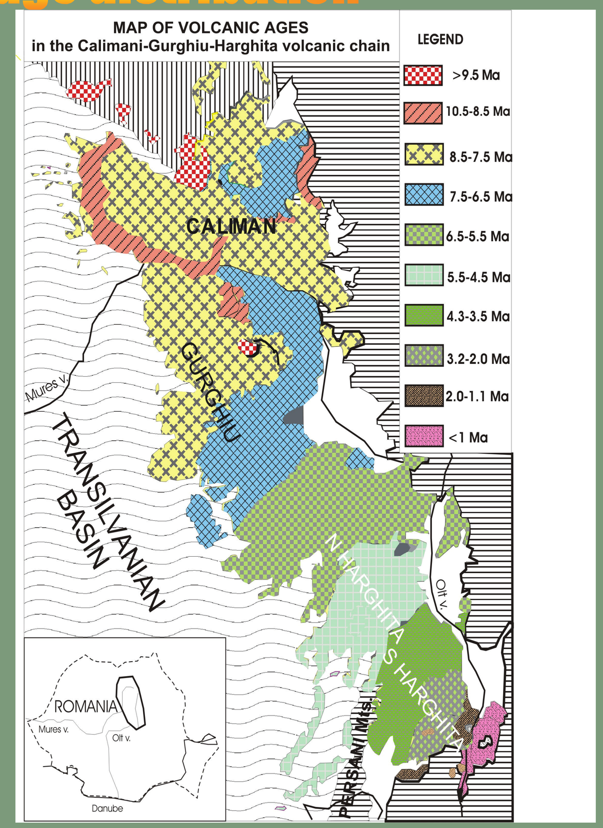
Study area

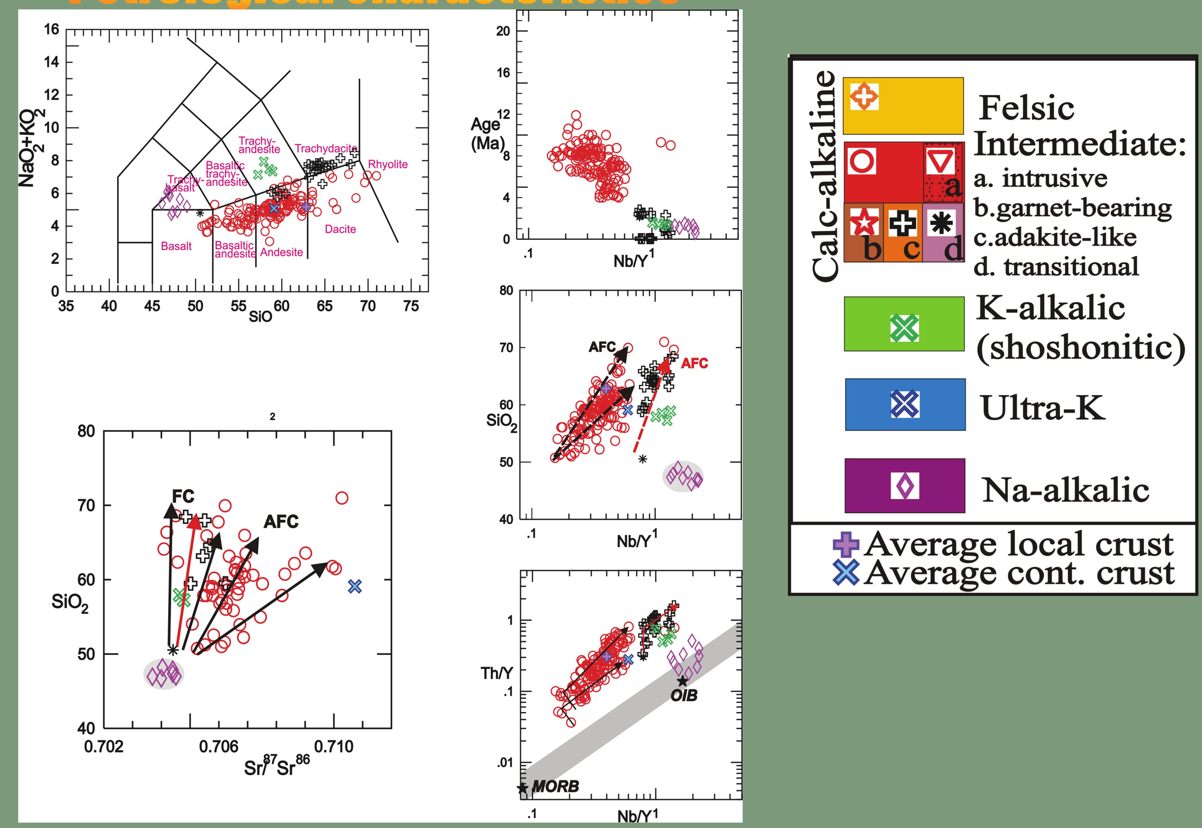


Volcanology and age distribution





Petrological characteristics



Calc-alkaline volcanism (11-3.9 Ma) = subduction-related magmatism along Călimani-Gurghiu-Harghita volcanic chain.

In South Harghita magma compositions changed at 3 Ma to adakite-like calc-alkaline and continued until recently, interrupted at 1.6-1.2 Ma by Na and K alkalic magmas.

Change in magma composition is related to changes in magma source and melting mechanism

Mineral chemistry

Laser ablation ICP-MS study and electron microprobe analysis

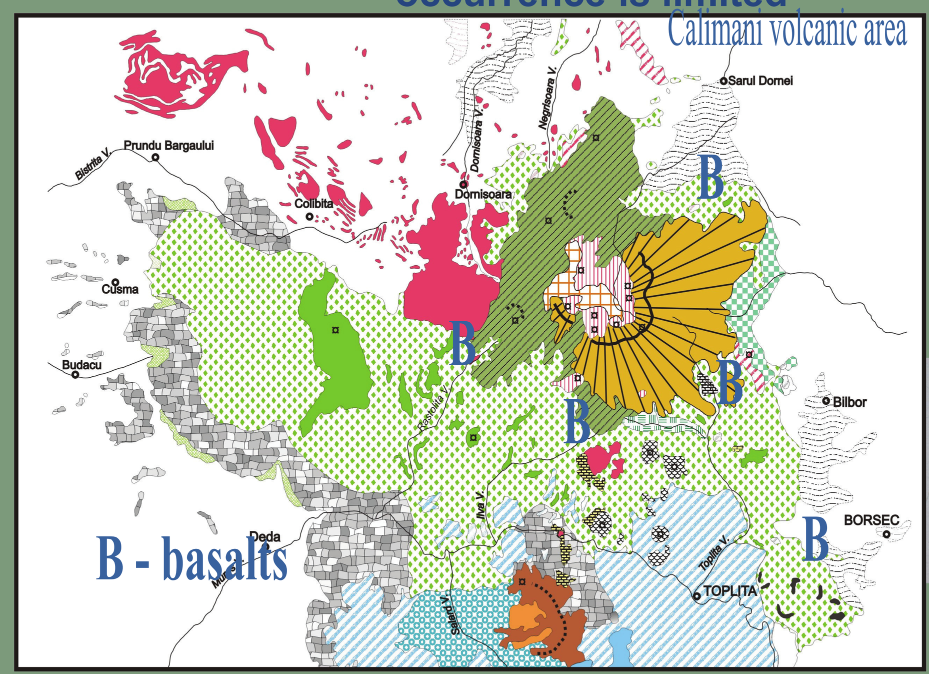
Whole rock analysis has limitations

Rocks record processes in magma chambers and conduits:

- Fractional crystallization
- Magma mixing
- Crustal assimilation

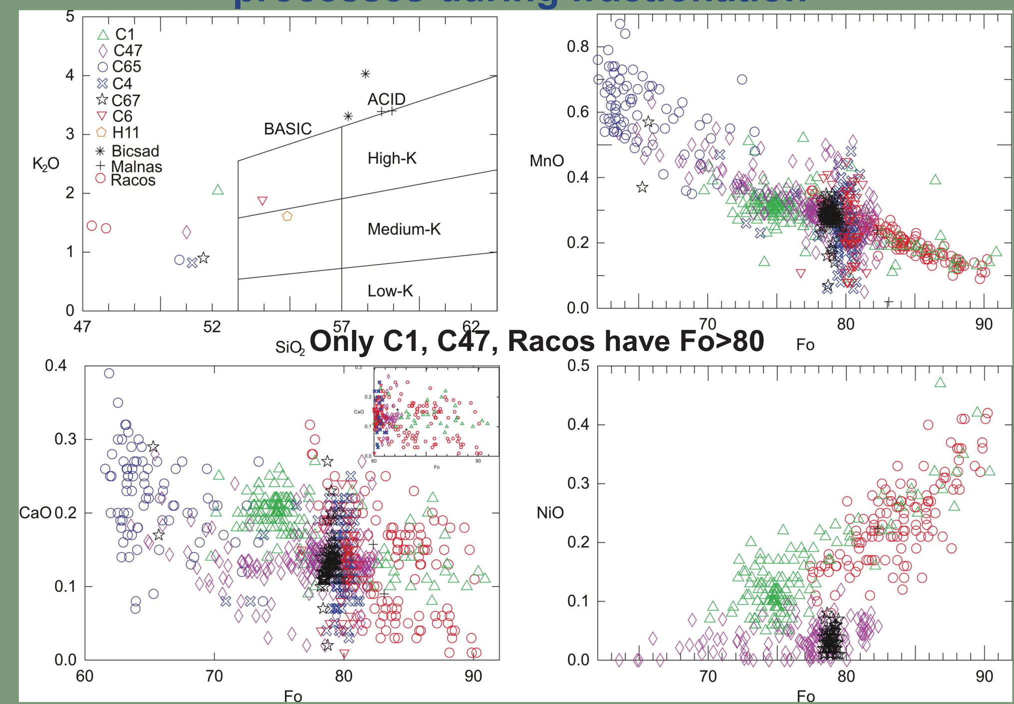
Source compositions and hence mantle processes are masked or at best averaged

Focusing on basalts that contain primitive liquidus phases (Olivine and Clinopyroxene), reduces the influence of magma chamber processes, but basalt occurrence is limited

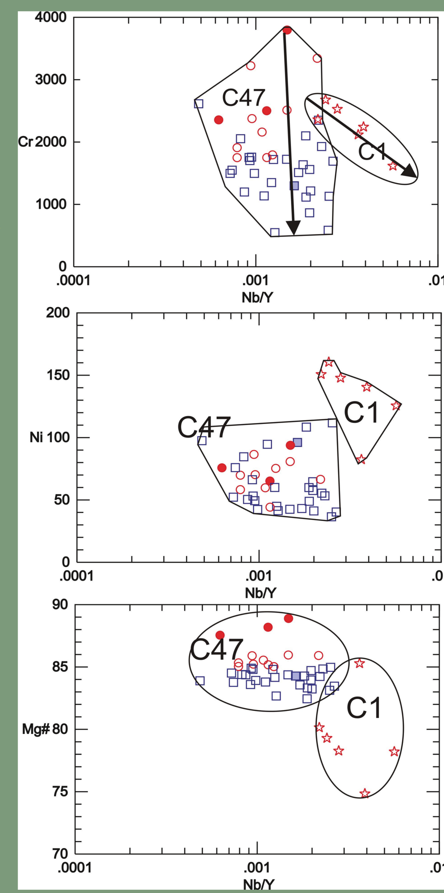


Procedure: ~4 kg rock, crushed and sieved, then hand picked individual crystals (30 - 40) at binocular, mounted in epoxy and polished.

Olivines show extremely diverse compositions in single rocks indicative of extensive mixing and back-mixing processes during fractionation



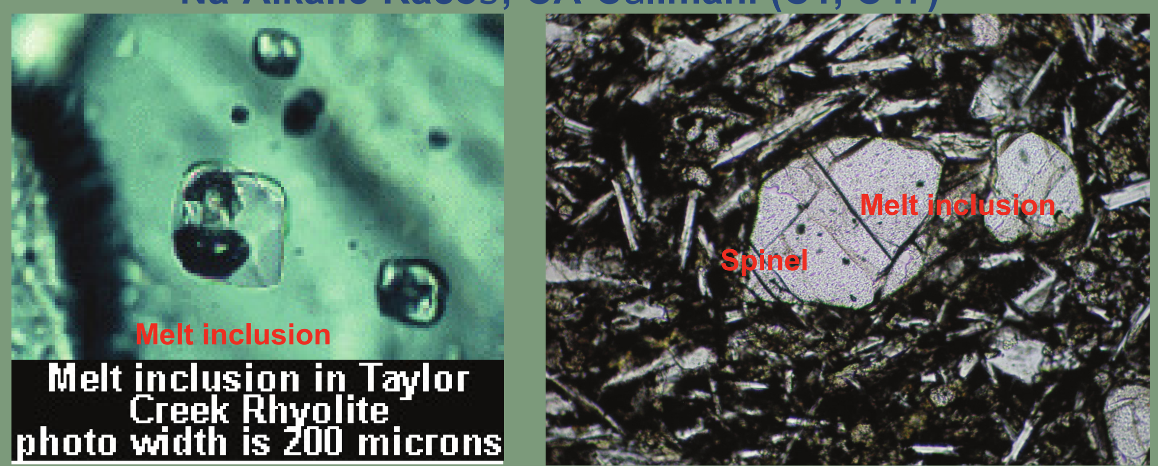
Early clinopyroxenes composition give a view of early and primitive magma chemistry:
-Extensive mixing during fractionation.



Study clinopyroxenes CA-Calimani (C1, C47)

emphasize two different sources

Study melt inclusions and spinels in the most forsteritic Olivines using laser ablation on homogenized inclusions Na-Alkalic-Racos; CA-Călimani (C1, C47)



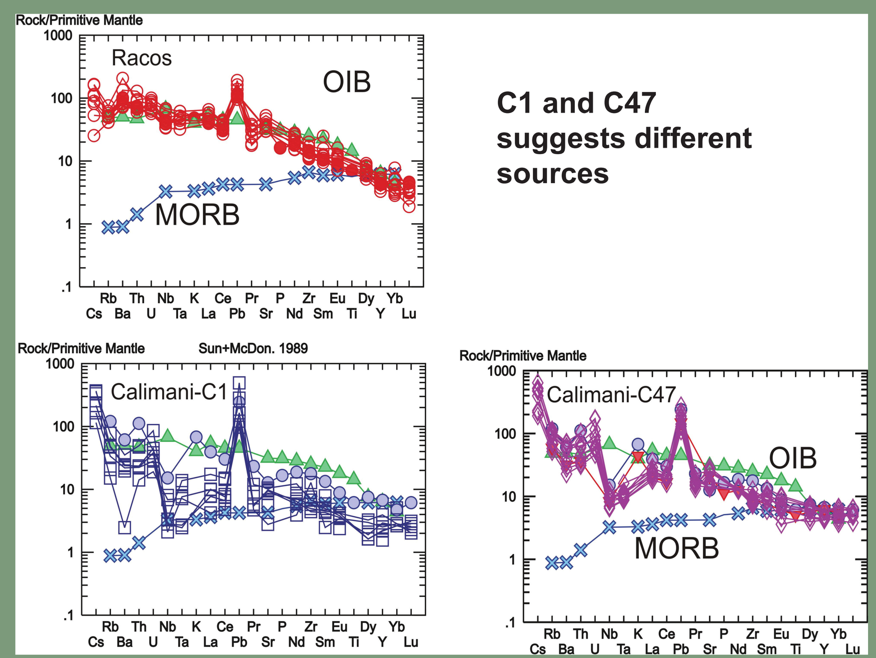
Melt inclusions and spinels give a snapshot of early and hence primitive magma chemistry: We can approach the source composition = melting processes
= subduction component
= asthenospheric components

Study melt inclusions in the most forsteritic Olivines with Fo>80

Comparison with whole rock- Rock to Primitive mantle ratio:

-Similar composition with whole rock:

Racos and C47 and similar but lower concentration in C1

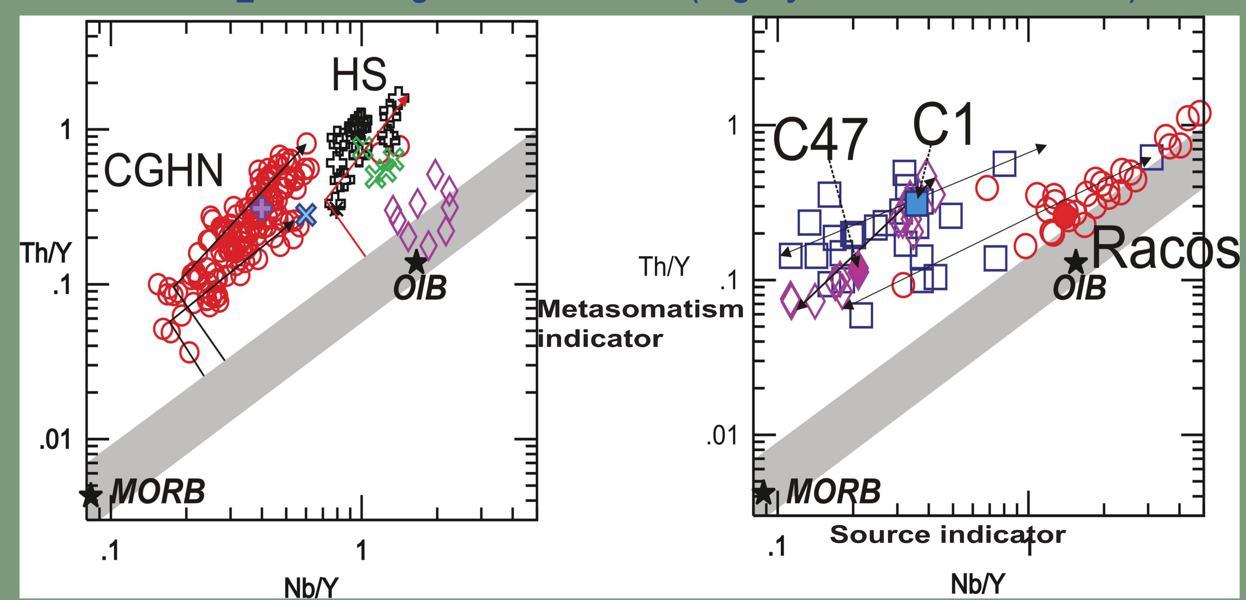


Study melt inclusions in the most forsteritic Olivines

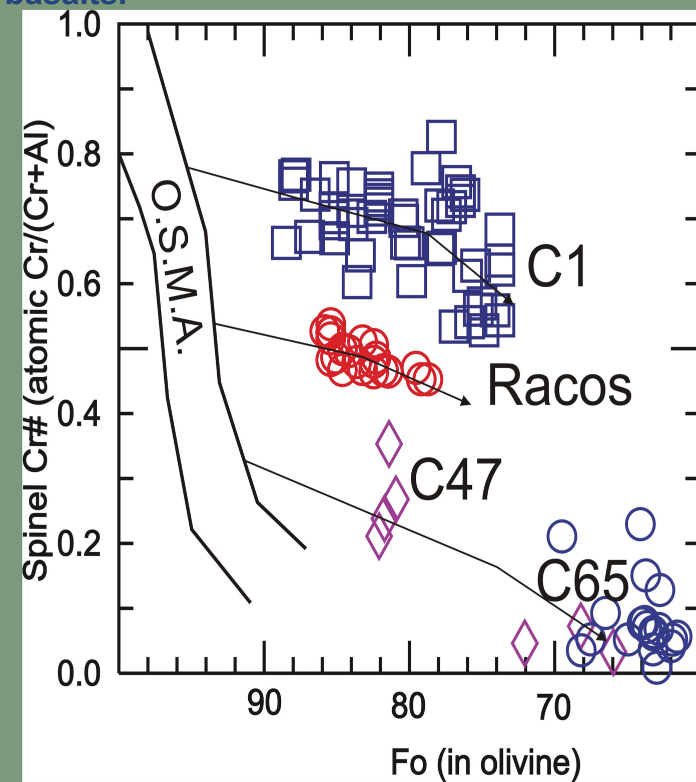
Trace elements:

Calc-Alkaline- C47 shows different source than C1, large source variation (metasomatized source)

Na-Alkalic_Racos – large source variation (slightly metasomatized source)

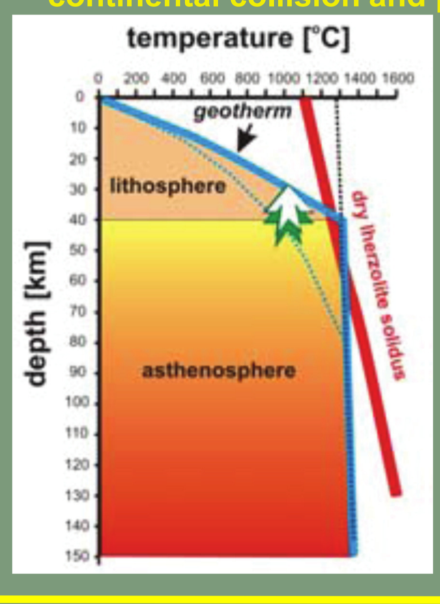


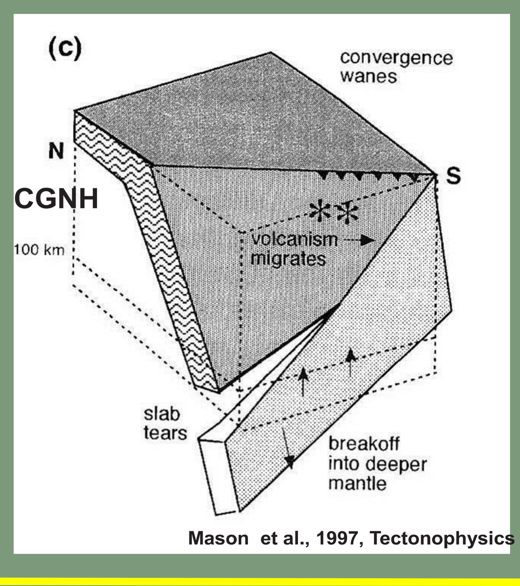
Cr-spinel(co-liquidus with olivine in primitive magmas) composition suggests different mantle source (peridotite) "fertility" for calc-alkaline Calimani basalts and Na-alkalic basalts.

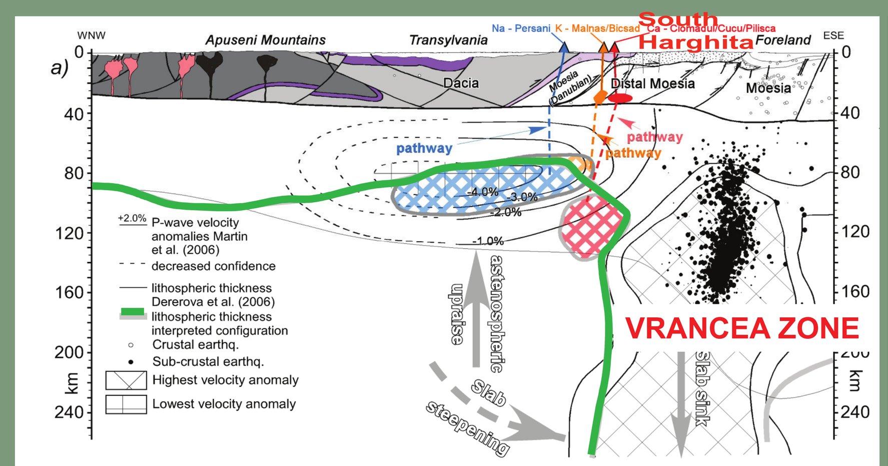


Post-collisional setting;

-Decompression melting due to thinning of lithosphere during extensional tectonic processes, slab breakoff and tearing following continental collision and passive upwelling of asthenospheric material;.







Two main geodynamic events during post-collisional times :

(1) slab-pull and steepening with opening of a tear window (forming adakite-like calc-alkaline magmas) and

(2) renewed contraction due to Adria push (forming Na & K alkalic magmas).

Adakite-like magmas = slab-fluid contribution;
K-alkalic = lithospheric mantle source;
Na-alkalic = asthenospheric mantle source

Conclusions

-The compositional range of Olivine and Clinopyroxene in each sample record mixing and back mixing processes during fractionation;

-The geochemical variation of melt inclusions and spinels in olivines with Fo>80 suggests their derivation from various compositional sources as small magma pockets, that were further variably mixed/mingled and fractionated as a single batch of magma to reach the surface; Mixing of melts probably took place at shallow crustal levels in small magma bodies rather than in the mantle or in large stable magma chambers.

-Two mantle-derived sources beneath Calimani were found for the first time;

-Whole rocks geochemistry does not define the source region being an average of various melt components and further fractionation processes. Probably the same with isotopic composition;

-In the East Carpathians there are two distinct mantle components:
variably subduction-modified lithospheric mantle and slightly modified asthenosphere which support slab breakoff (CGNH) and slab-pull and tearing models (SH).

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