ClerVolc
Centre Clermontois de Recherche sur le Volcanisme

Laboratoire Magmas & Volcans

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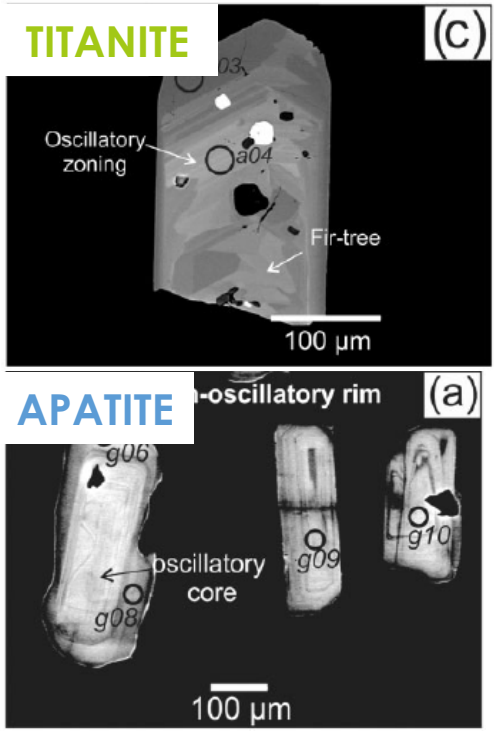
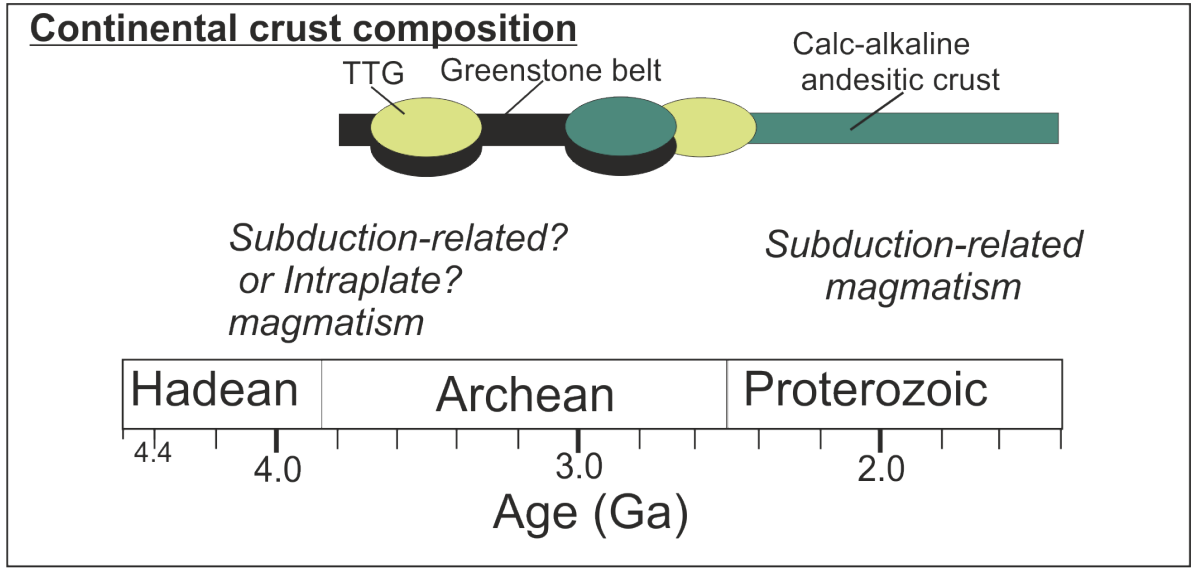




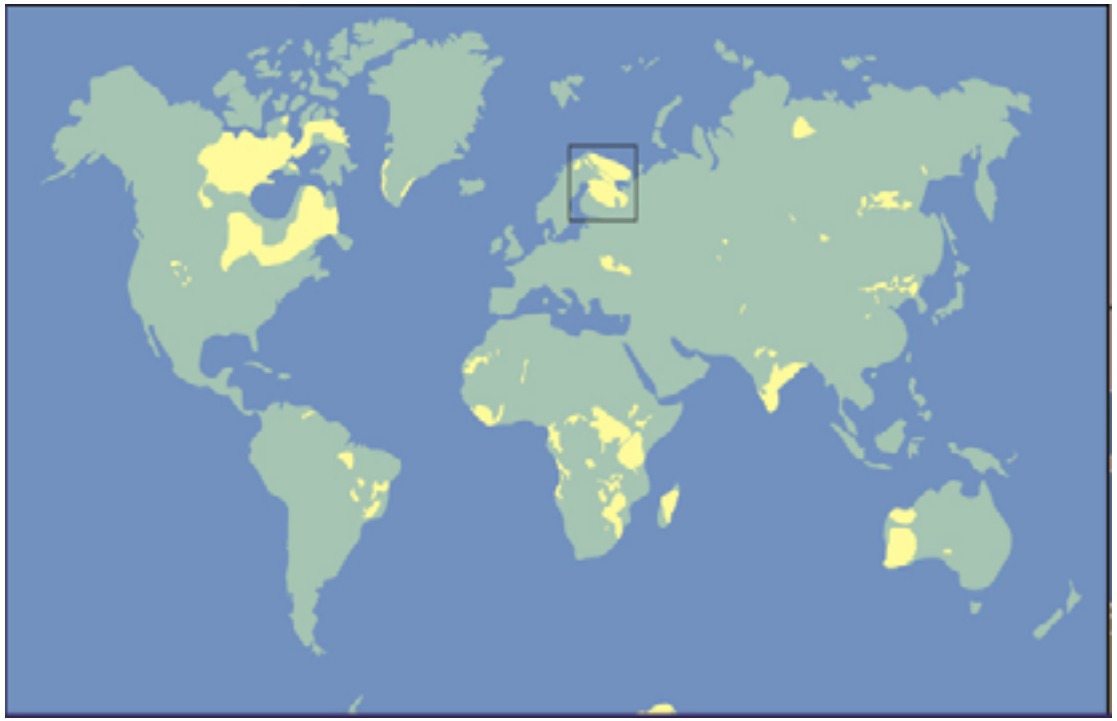
Trace elements in apatite and titanite : a new proxy to discriminate magma evolution?

Collaborators: C. Storey, M. Fowler, O. Laurent, C. Antoine, M. Guitreau, O. Nebel, E. Heilimo

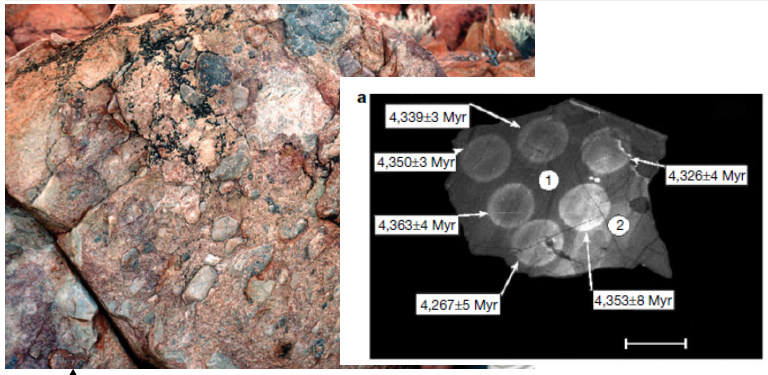
E. Bruand – EGU 2020

How to link the Earth dynamic and the magmatic record before 2.5Ga?

Outcrop limited before 2.5Ga



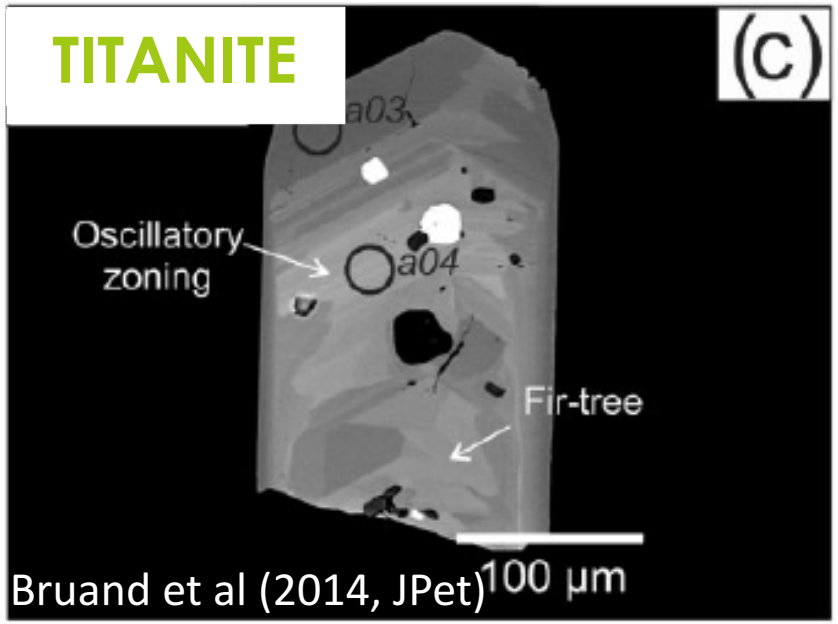
Oldest minerals: Jack Hills zircons



Oldest rocks: TTG

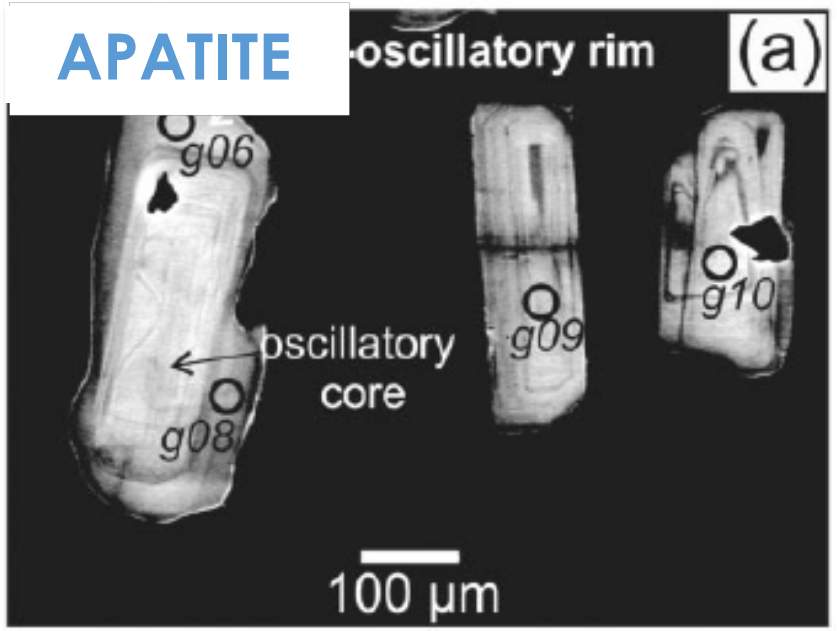
Underexplored accessory minerals

TITANITE

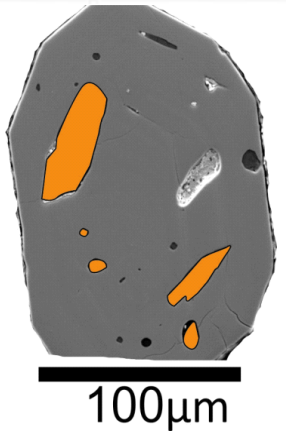


Bruand et al (2014, JPet)

APATITE

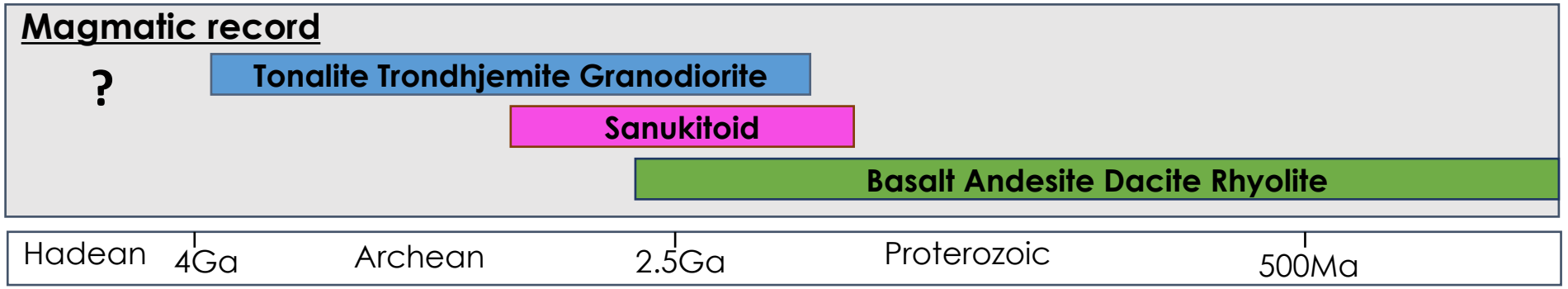


- ✓ Record nature of the host rock
- ✓ Occur in mafic and felsic compositions
- ✓ Apatite inclusions in zircon and titanite



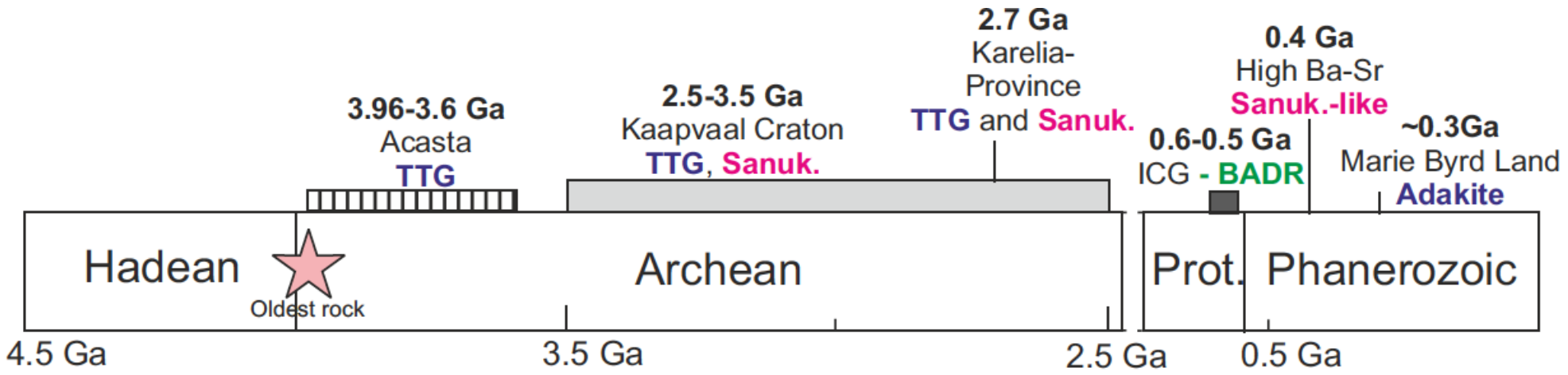
Bruand et al (**2016, Geology**)

Magmatic record through time



Goal of this work: Study the **behaviour and chemical signature** of accessory minerals in magmatic rocks through time. Are they allowing magmas discrimination?

Samples studied in this contribution



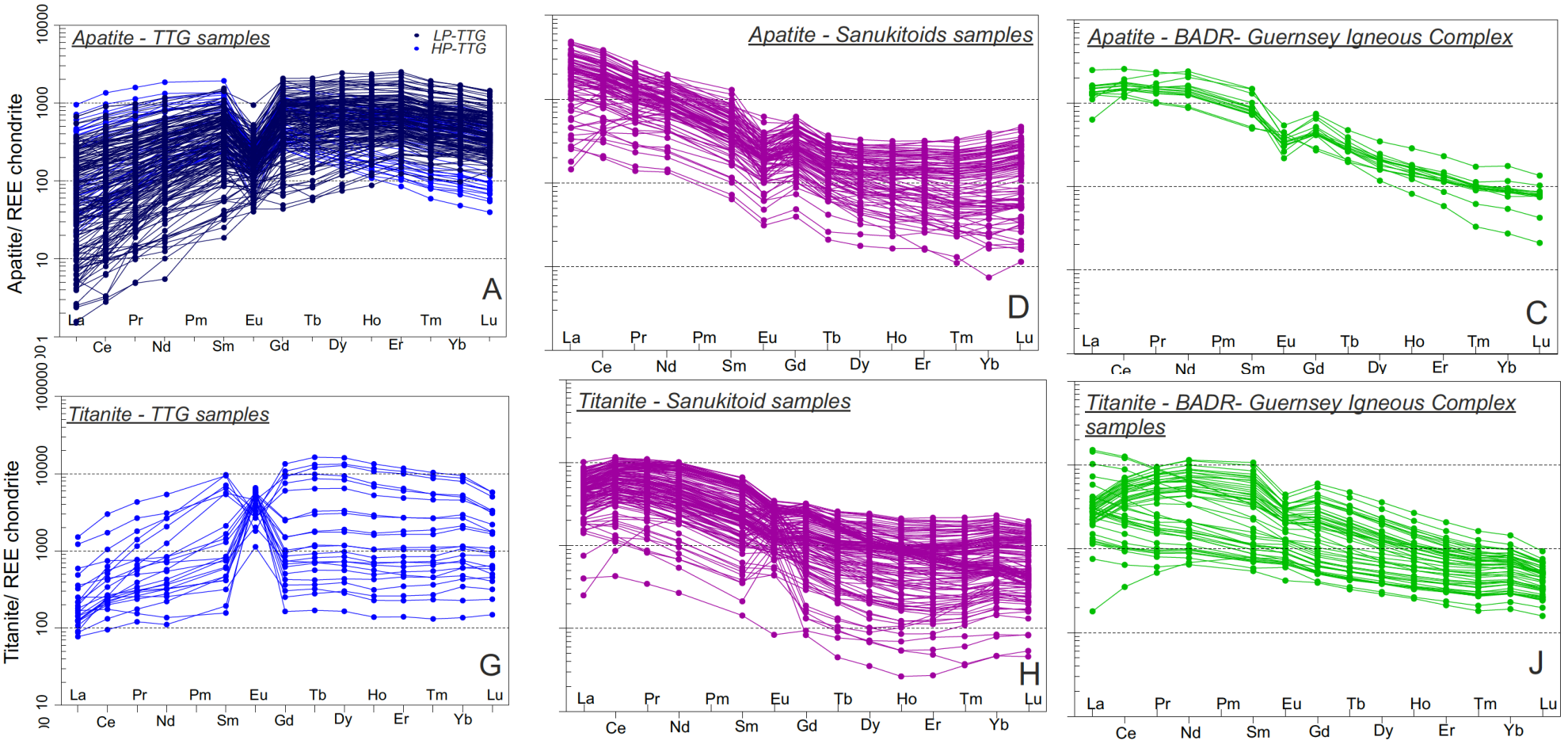
Accessory minerals trace element chemistries

✓ Magmas discrimination using Accessory minerals

(Bruand et al., 2020, GPL)

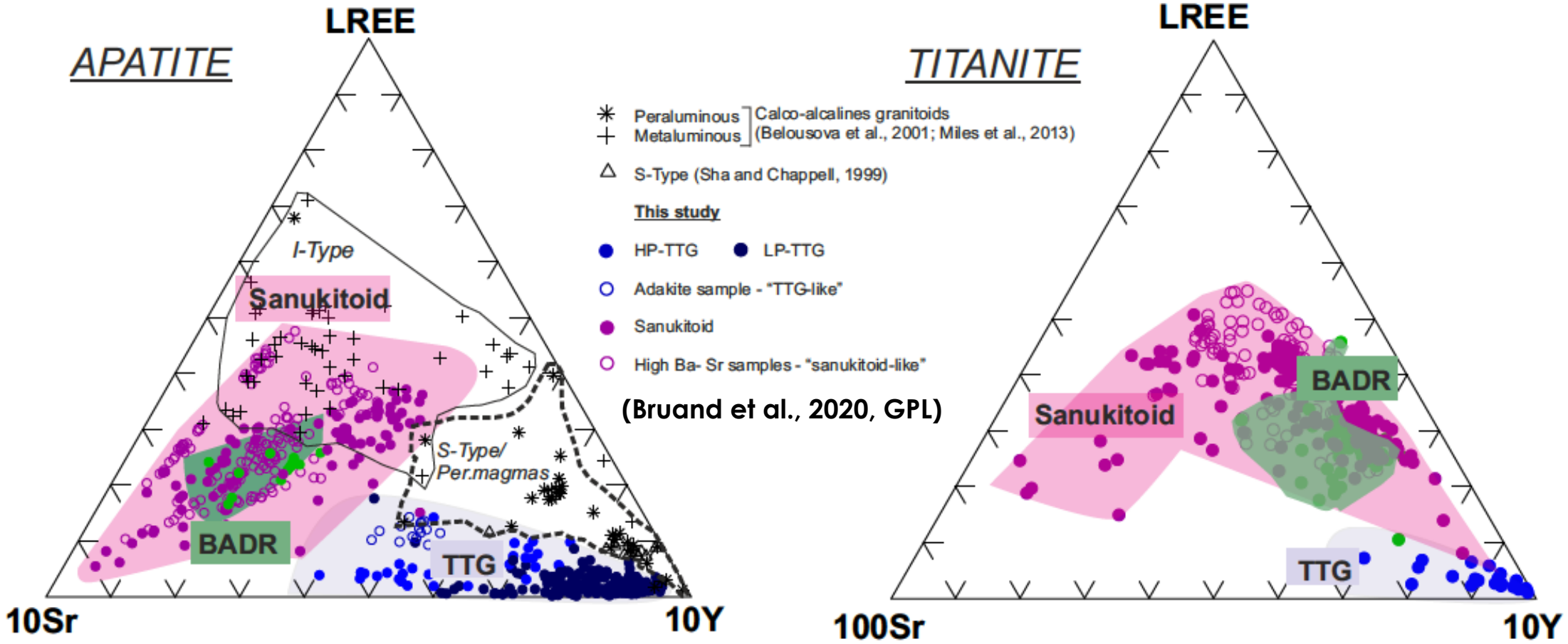
APATITE

TITANITE



Apatite and titanite chemistries in TTG are very peculiar. They are depleted in LREE and enriched in HREE.

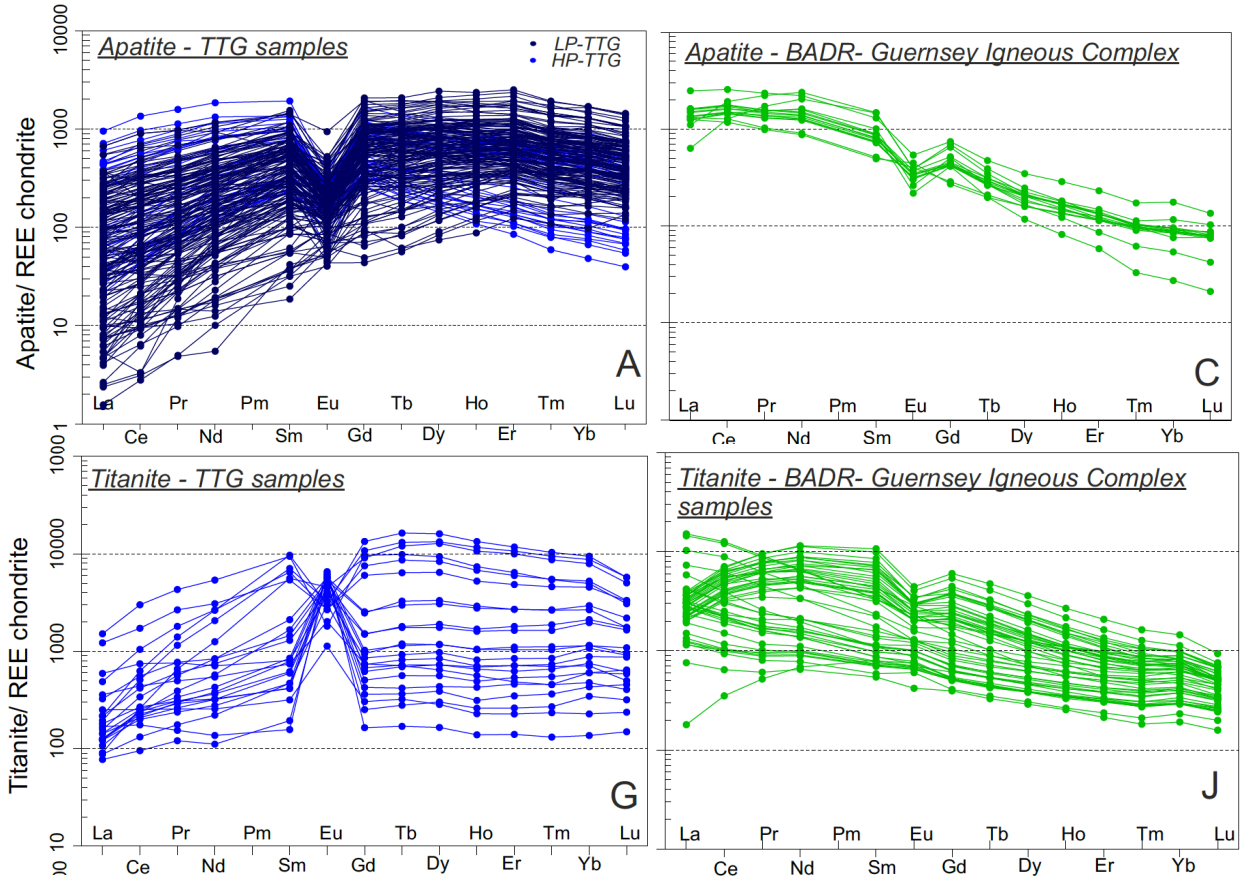
Accessory minerals and crustal evolution



Ternary diagram using LREE-Sr and Y allow to discriminate TTG from different type of magmas that occur through time. Why?

TTG chemical peculiarity?

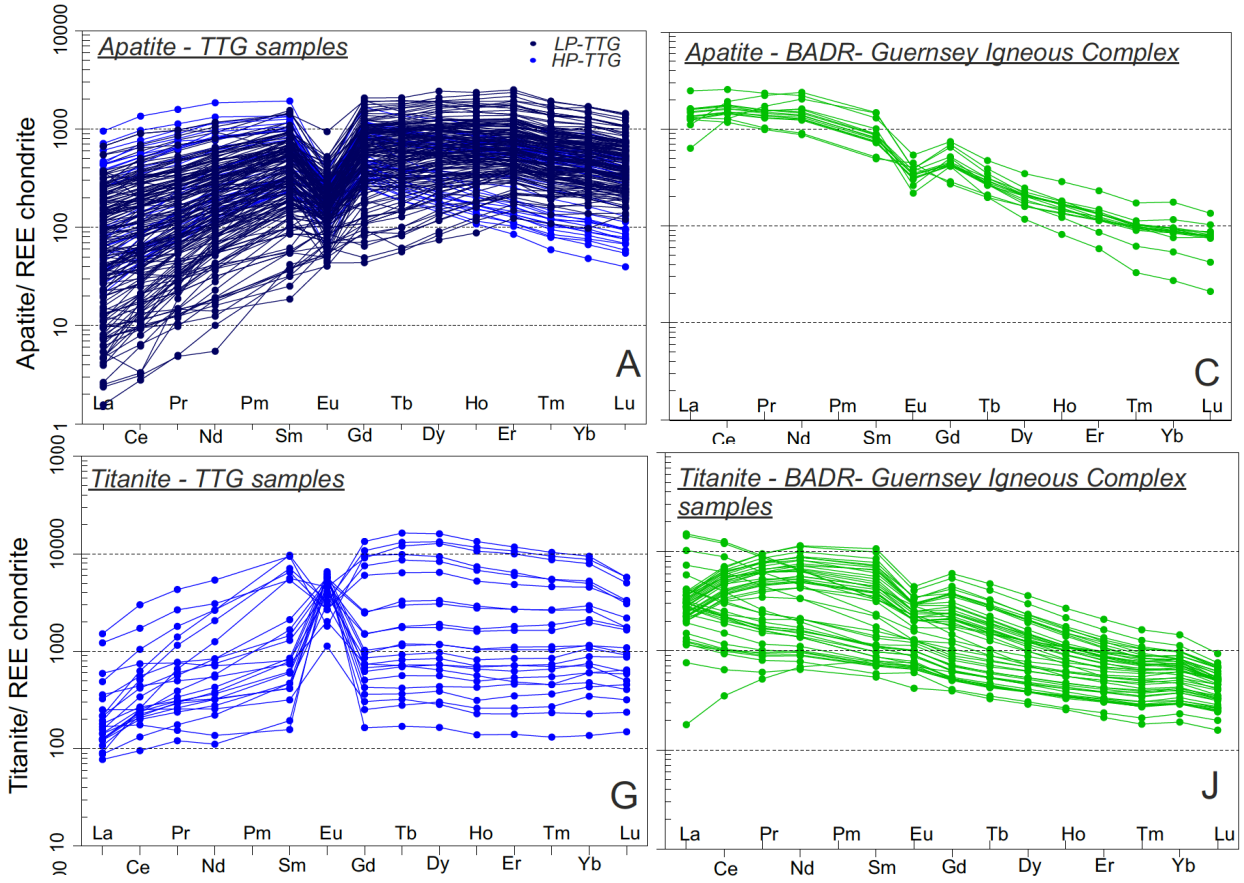
✓ Magmas discrimination using Accessory minerals



The main discriminating elements for TTG granitoids are LREE and HREE-Y

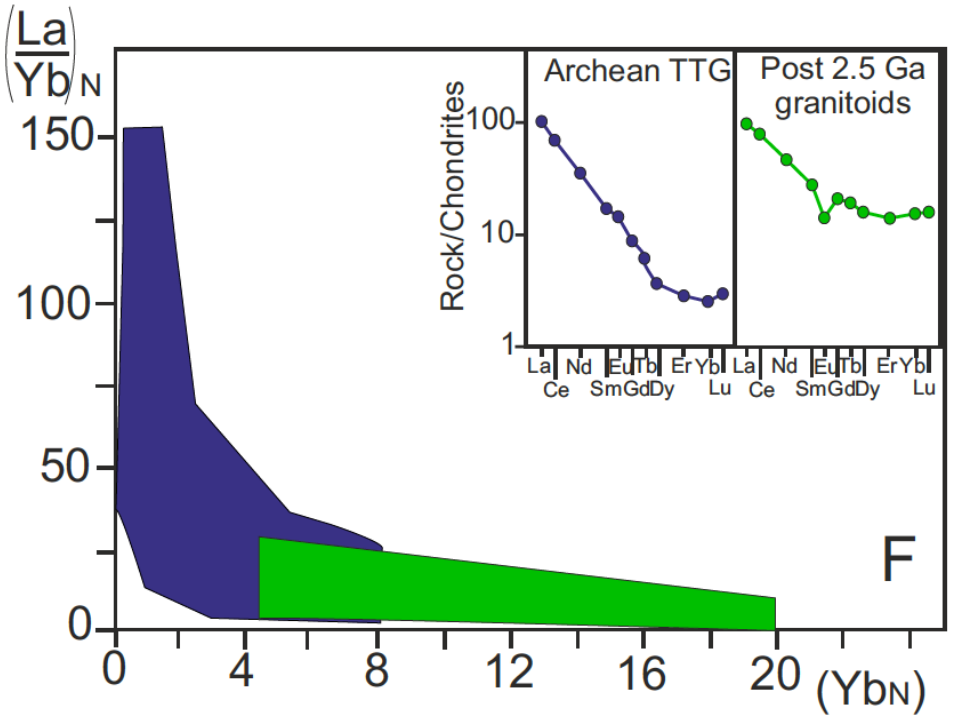
TTG chemical peculiarity?

✓ Magmas discrimination using Accessory minerals



The main discriminating elements are LREE and HREE-Y

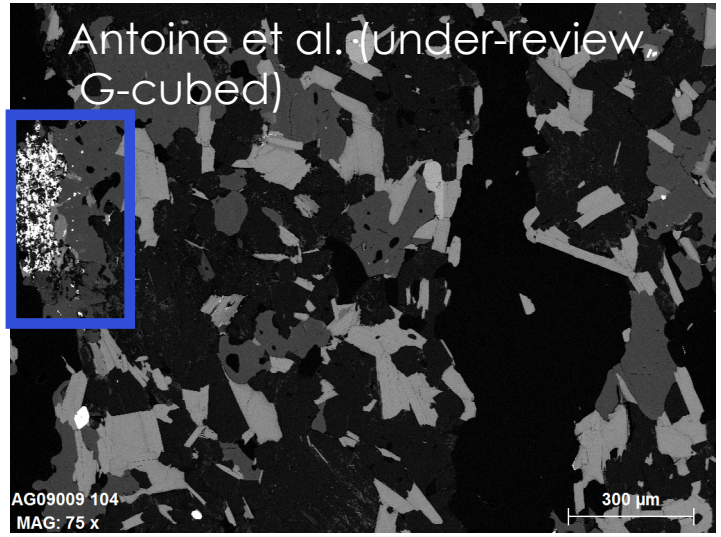
✓ Remember the WR signature?



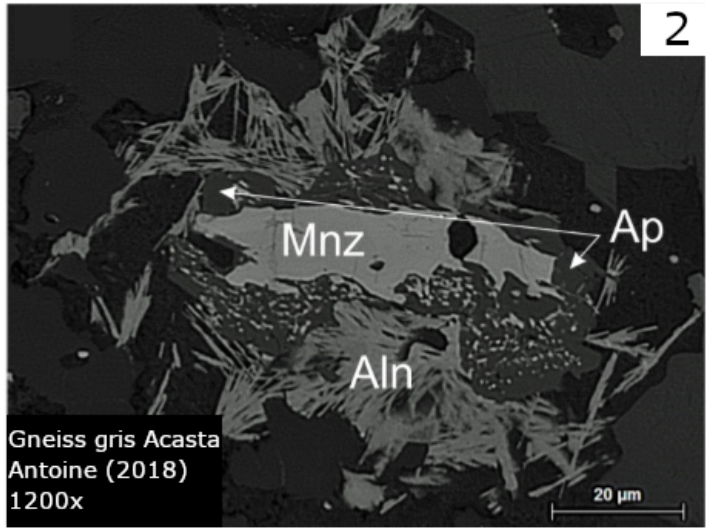
How can we explain the dichotomy between WR and accessory signature?

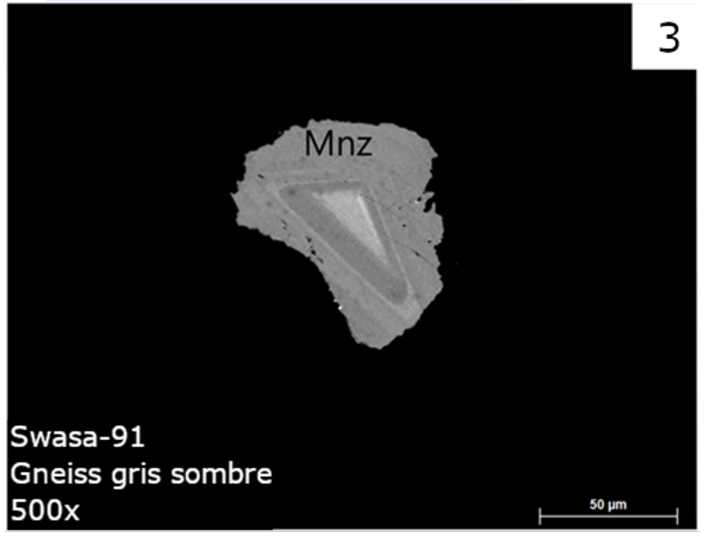
Accessory minerals and crustal evolution

✓ **You need another LREE-bearing phase**



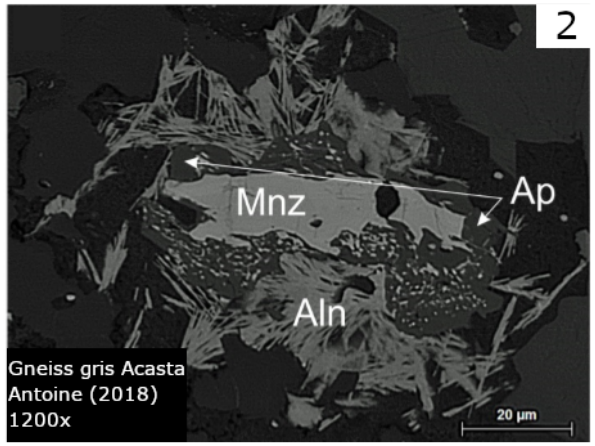
Monazite is the missing LREE phases explaining the dichotomy between the LREE content of apatite, titanite and the the whole-rock.

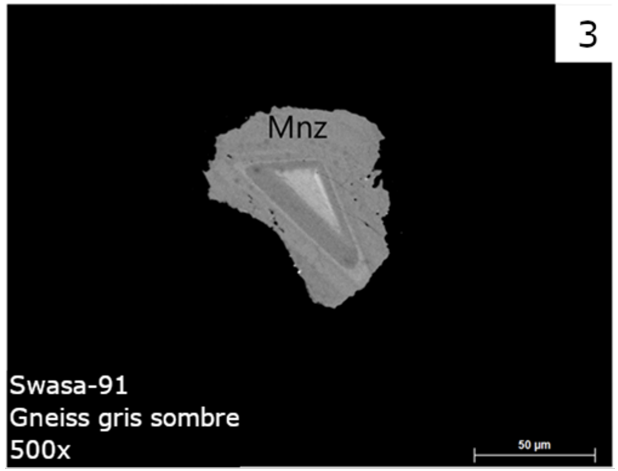


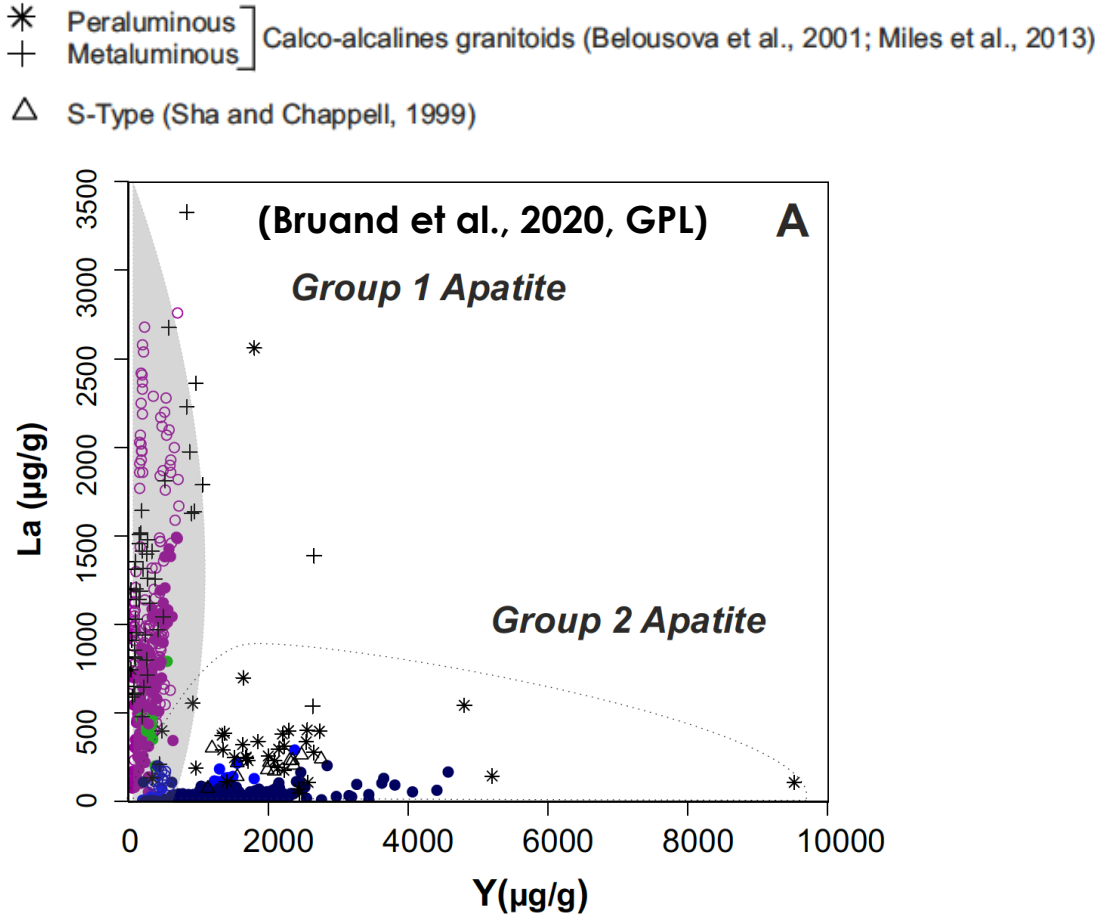


Accessory minerals and crustal evolution

✓ **Monazite is the „missing" LREE phase**





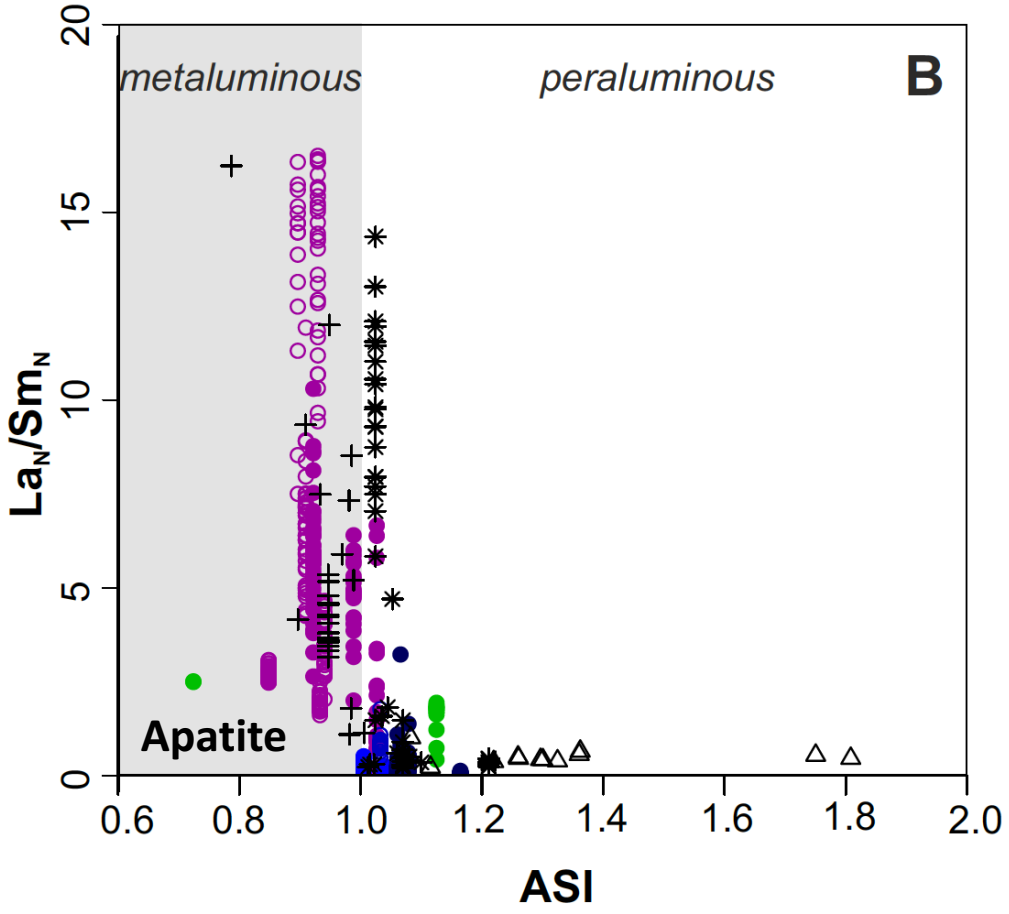


✓ **Two groups of apatite can be identified based on this diagram**

✓ **This grouping is strongly dependent on the presence of mz and on the ASI of the granitoid**

Accessory minerals and crustal evolution

✓ **Aluminium Saturation Index dependence**



This study ● HP-TTG ● LP-TTG ● Sanukitoids ○ Adakite sample "TTG-like" ○ High Ba- Sr samples "sanukitoid-like" ✳ Peraluminous + Metaluminous Calc-alkaline granitoids (Belousova et al., 2001; Miles et al., 2013) △ S-Type (Sha and Chappell, 1999) ● BADR

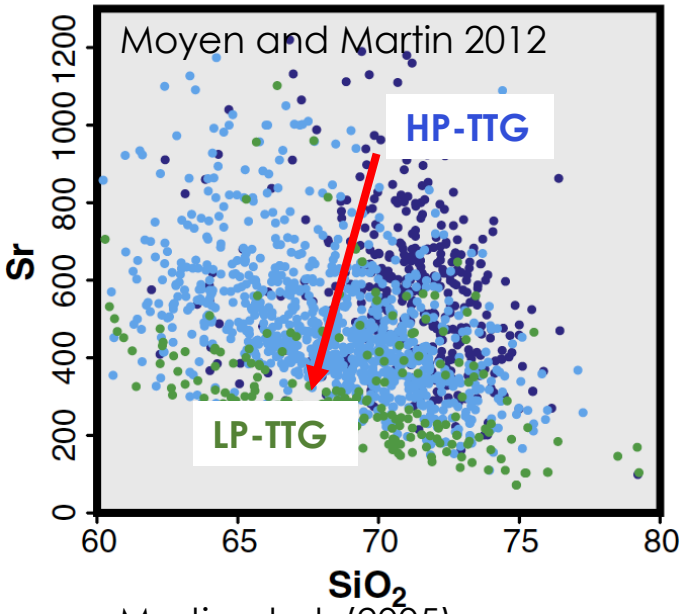
✓ **LREE intake of apatite is strongly dependent on ASI**

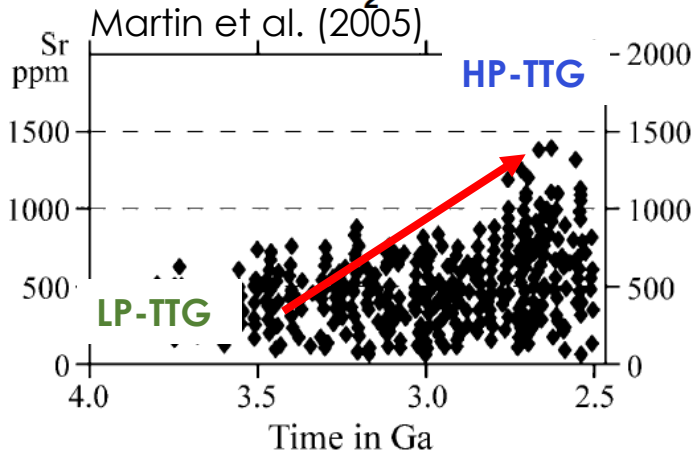
✓ **Consistent with previous experimental work of apatite and monazite solubilities** (e.g. Harrison and Watson, 1984 ; Pichavant et al.,1992, Montel et al., 1986) **and work on natural samples** (Bea and Montero, 1999; Sha and Chappell, 1999)

But this does not fully explain the systematically lower La content of TTG apatite/titanite compare to other magmas. Neither the HREE in those phases…

Accessory minerals and crustal evolution

✓ **The different TTG – Depth of melting**

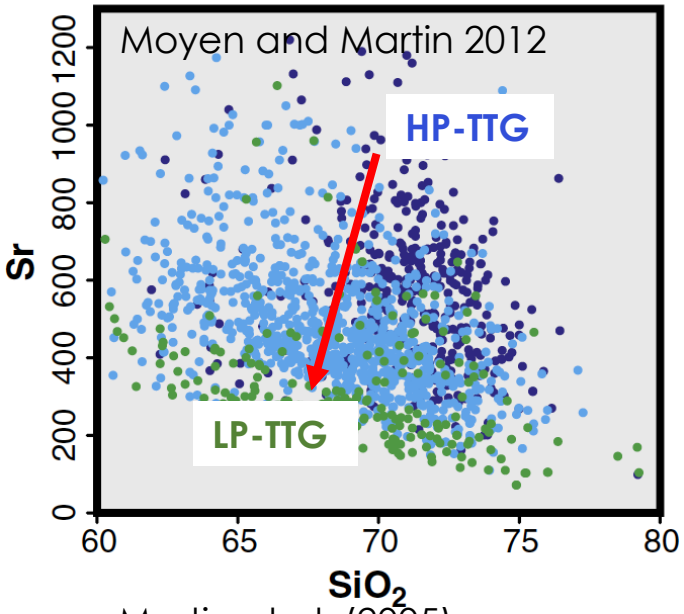


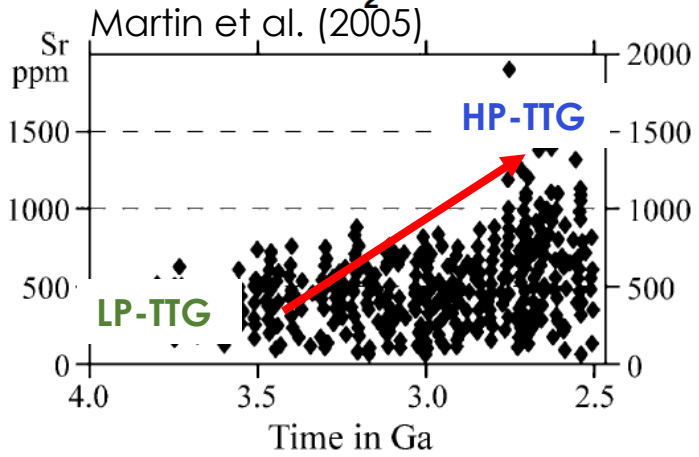


Sr content in TTG whole-rock is commonly interpreted as the indirect proof of the depth of melting of the TTGs source

Apatite composition: tracer of source?

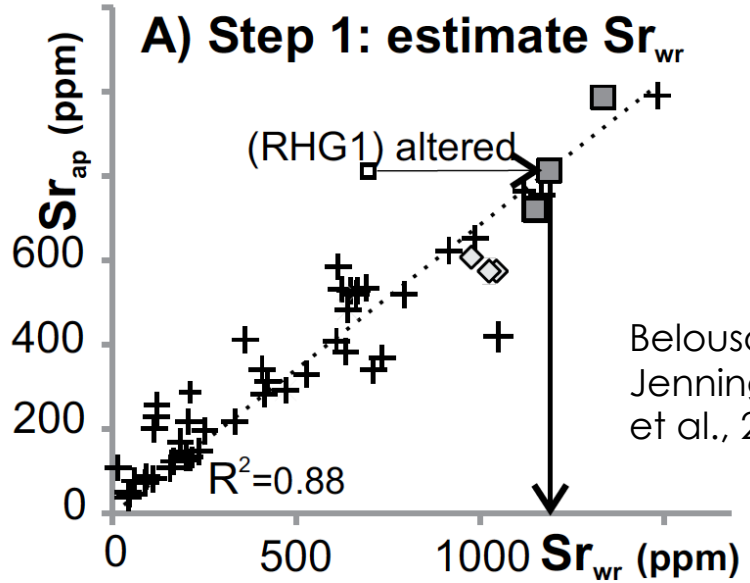
✓ **The different TTG – Depth of melting**





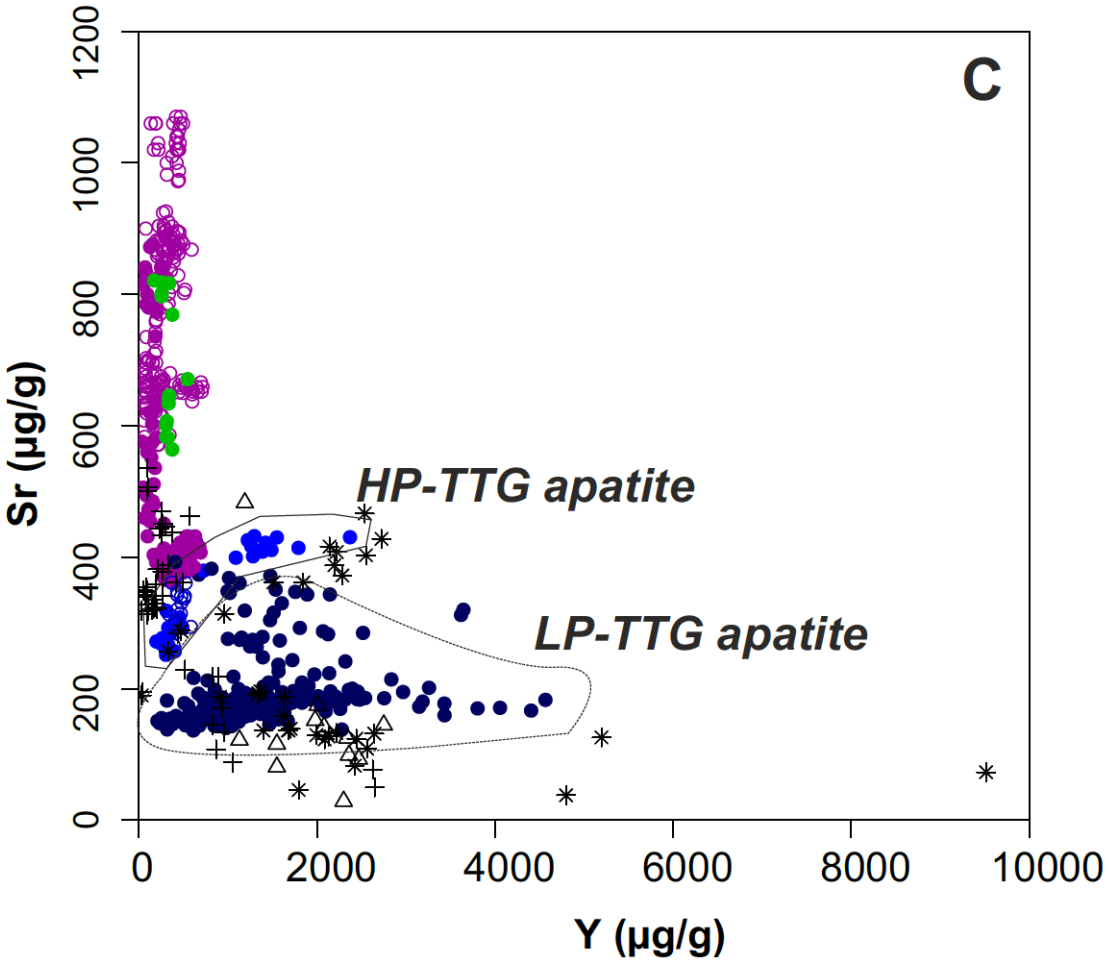
Sr content in TTG whole-rock is commonly interpreted as the indirect proof of the depth of melting of the TTGs source

We know that SrWR correlate with SrAp in granites



Belousova et al., 2001; Jennings et al., 2011; Bruand et al., 2016

Apatite composition: tracer of TTG source?



Sr in apatite seems to discriminate HP from LP-TTG

Summary

- ✓ Trace elements in apatite and titanite are highly sensitive to their host granite composition and source
- ✓ Sr in apatite discriminate HP from LP-TTG
- ✓ Ternary diagram using LREE-Sr and Y allow to discriminate the different type of magmas that occur through time.
- ✓ The result of this study **encourage application to the detrital rock record**. Voluminous data exist on zircon. The results described above promise much tighter constraints on parent rock identity, thus **providing vital access to the primary history of eroded terranes and helping to reconstruct the historical evolution of continental crust from the early Earth to the present day**.
- ✓ **Interested about accessory inclusions in zircon? ➔ Check Poster Antoine et al. Session GMPV4.3 https://meetingorganizer.copernicus.org/EGU2020/EGU2020-9848.html**