

# Rare-metal ore occurrences, related to the Late Archean A-type alkali granites from the Keivy zone (NE Fennoscandian shield)



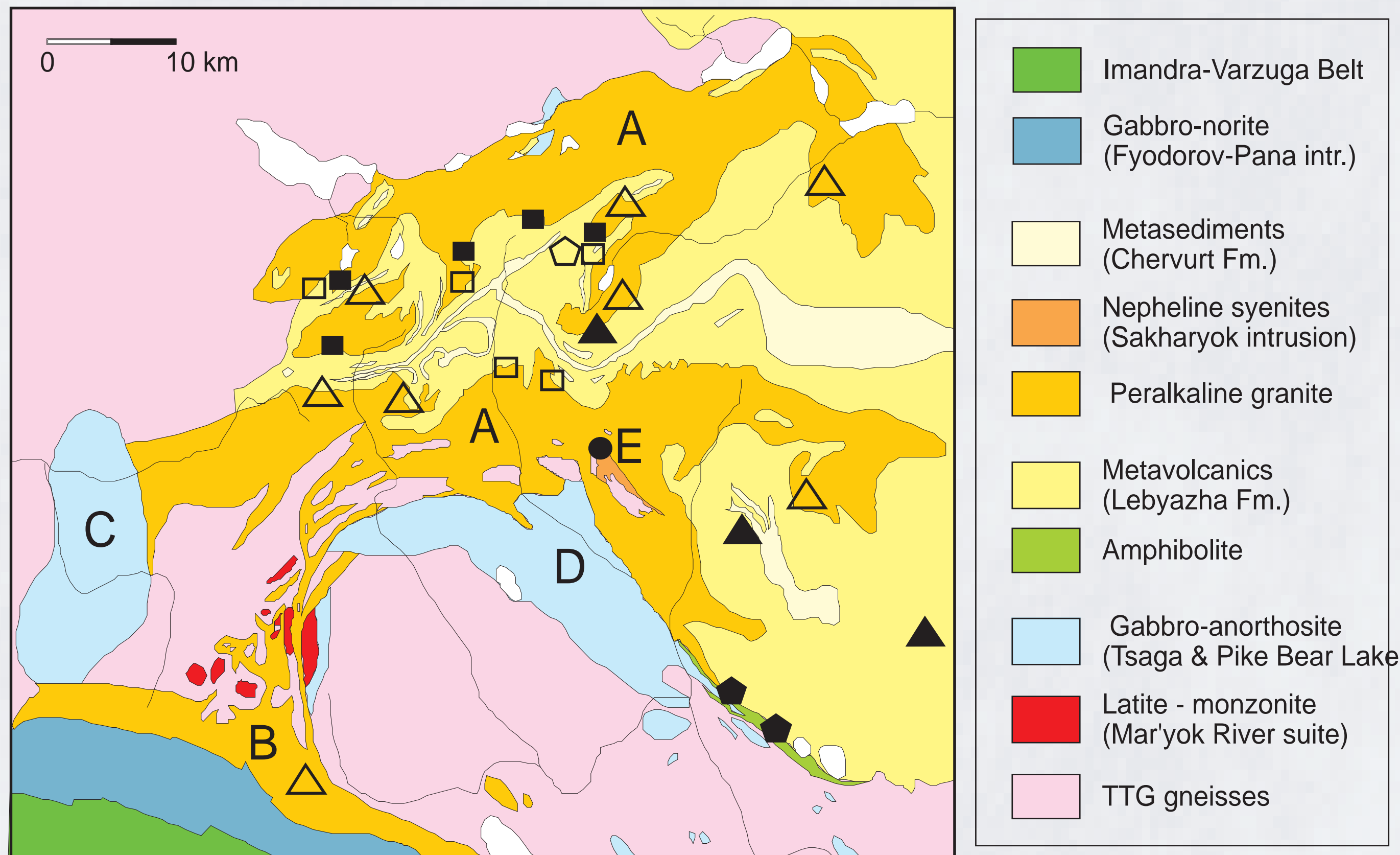
Dmitry Zozulya<sup>1</sup>, Nelson Eby<sup>2</sup>

<sup>1</sup>Geological Institute, Kola Science Centre, Apatity, Russia

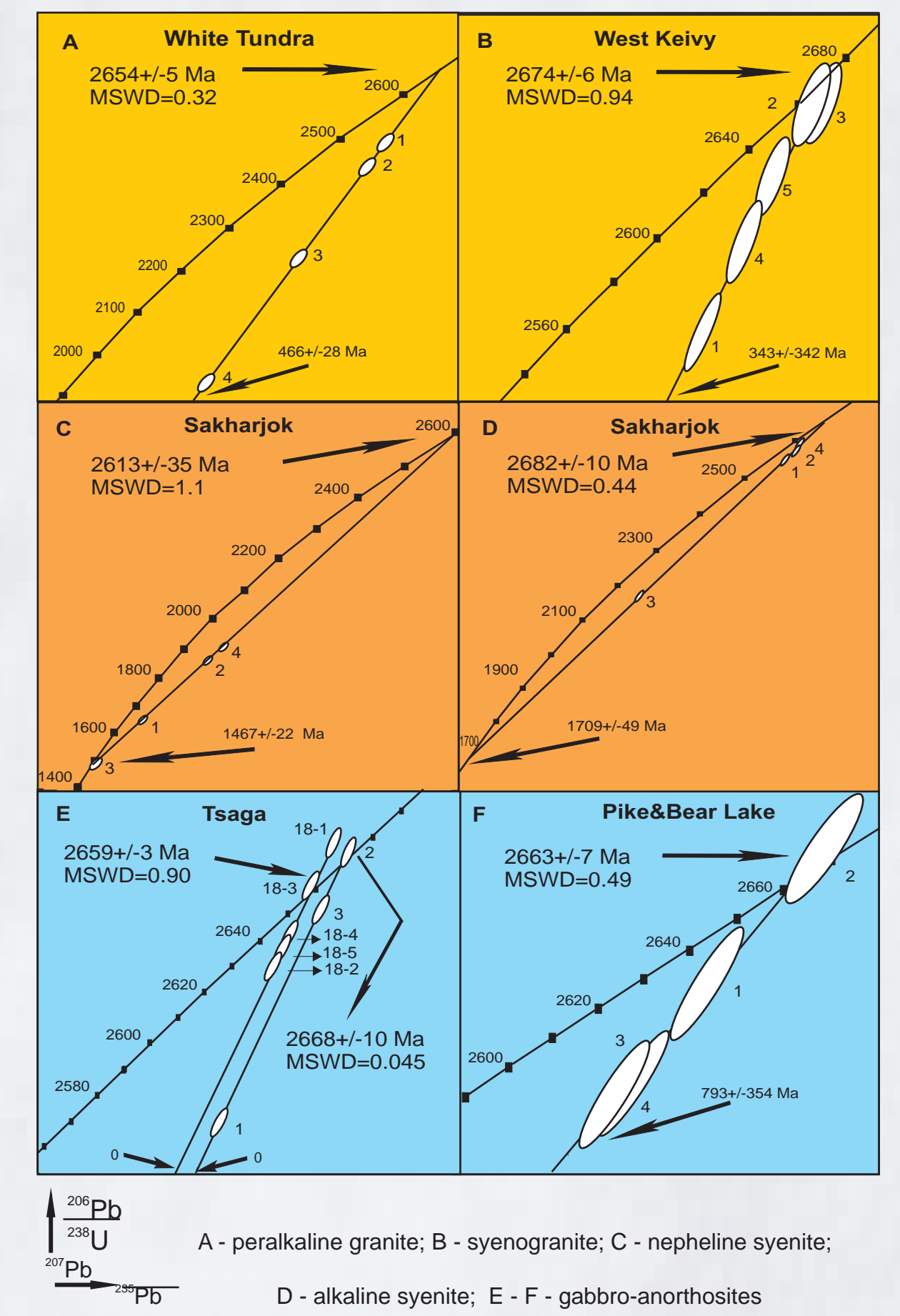
<sup>2</sup>University of Massachusetts Lowell, USA



## Geology and age of the Keivy anorogenic complex in the Kola Peninsula, NW Russia

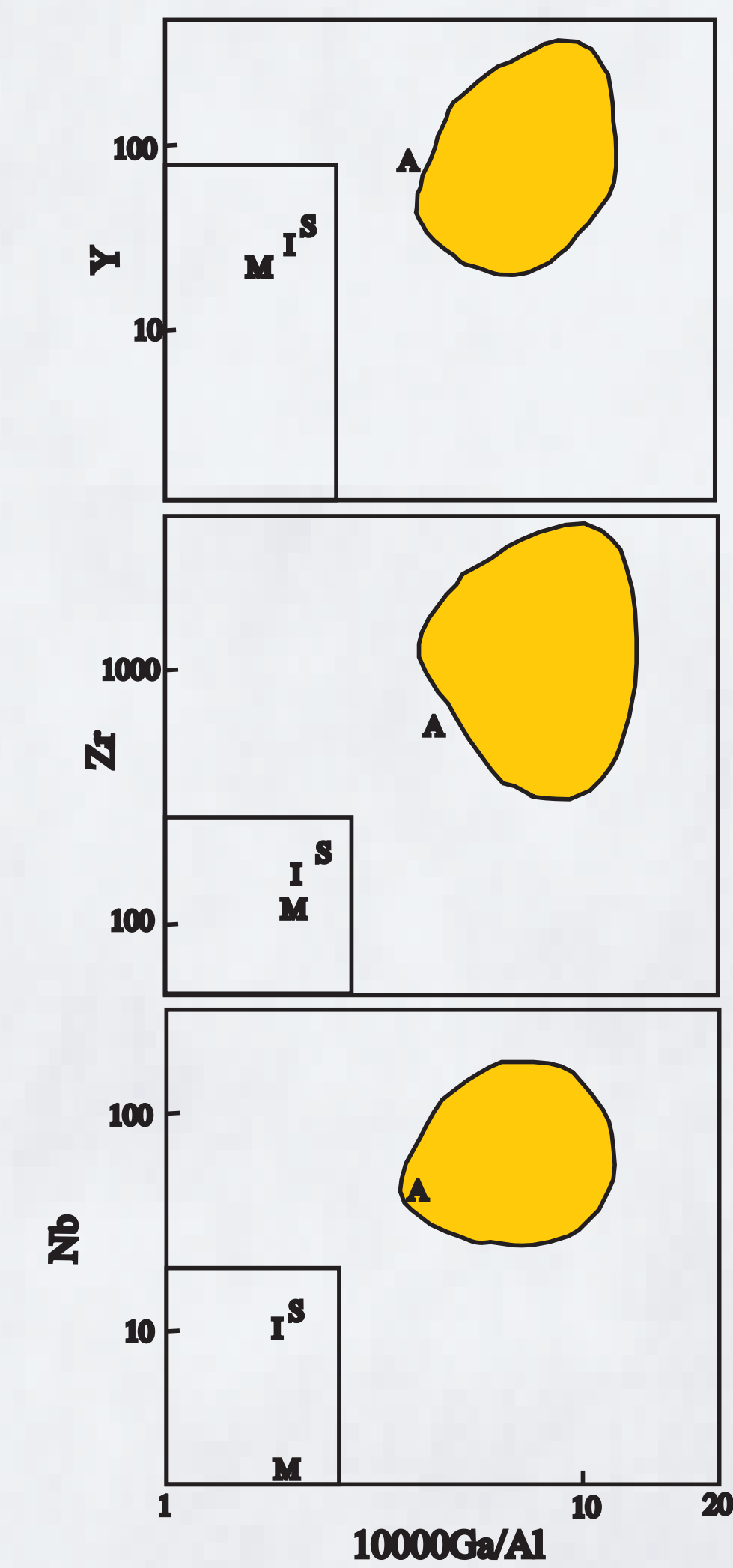


A suite of peralkaline granites and associated syenite and of massif-type anorthosites is found in the Archean Keivy terrane of the NE Baltic shield. The Keivy peralkaline granite complex consists of 2650-2660 Ma aegirine-arfvedsonite granites (six massifs of a few hundred meters thicknesses and with the total exposure area of ca. 2500 km<sup>2</sup>), 2670 Ma lepidomelane-ferrohastingsite syenogranites in margins of some massifs, and 2680 Ma lepidomelane-ferrohastingsite syenite dykes cutting the TTG basement. Small dike-like bodies of 2610 Ma nepheline syenite cut the West Keivy peralkaline granite massif. The Keivy anorthosite complex consists of several large (up to the 170 km<sup>2</sup>) lopoliths composed mainly of anorthosite and gabbro-anorthosite and spatially confined to granite

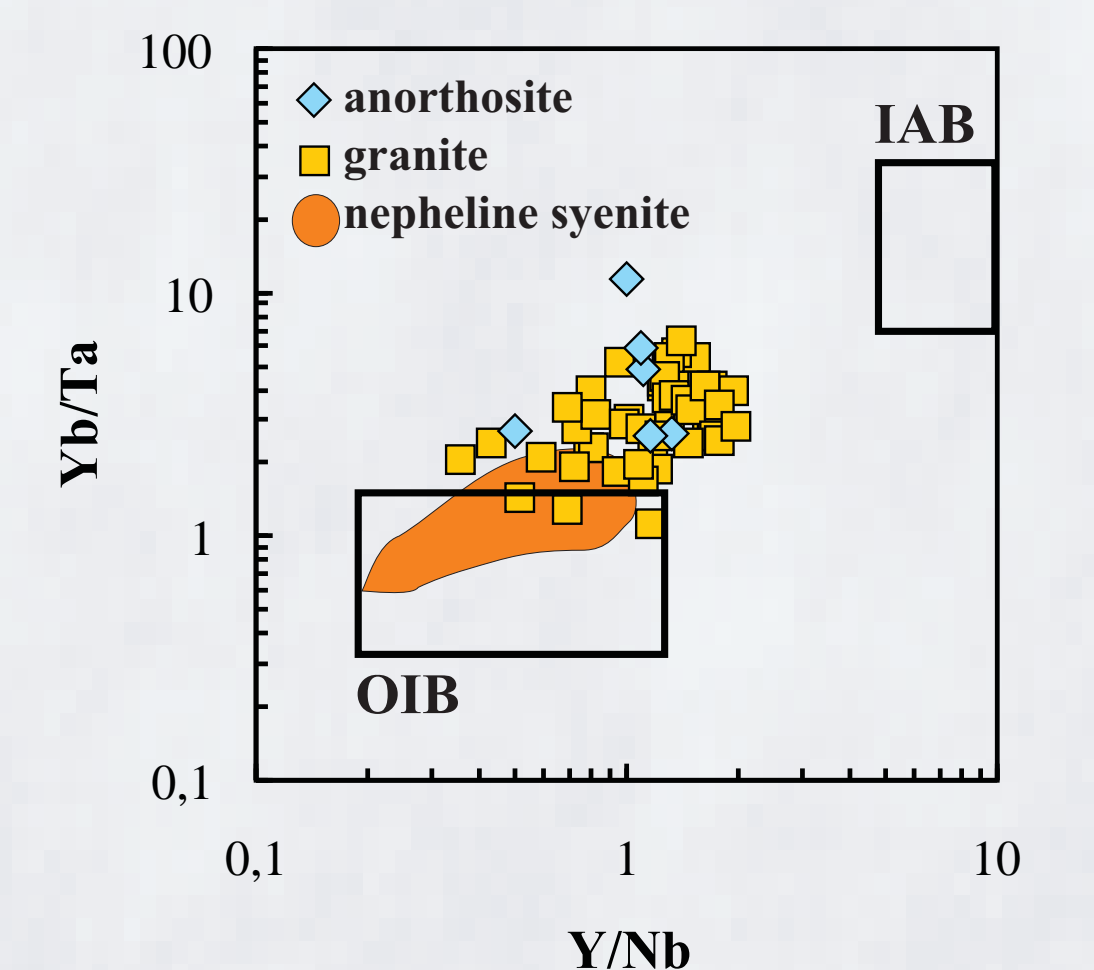
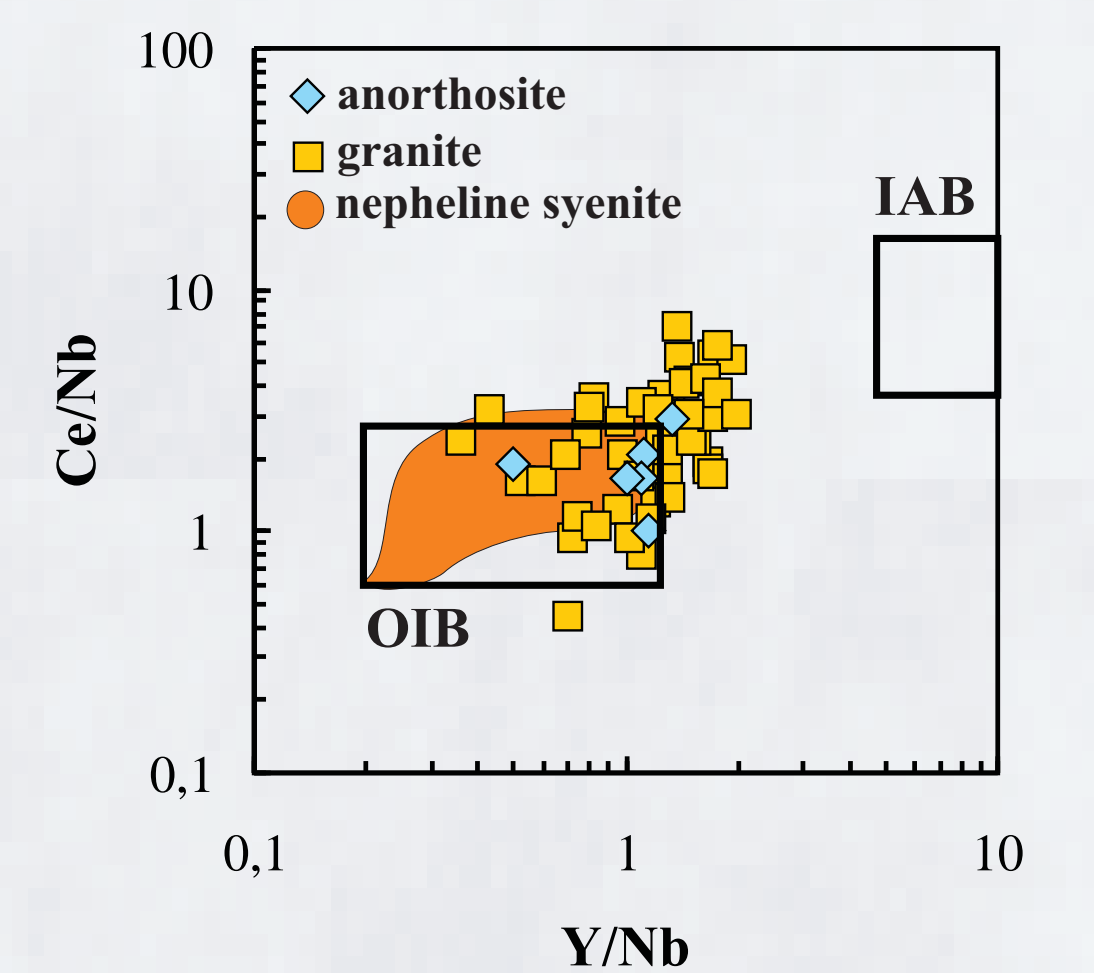
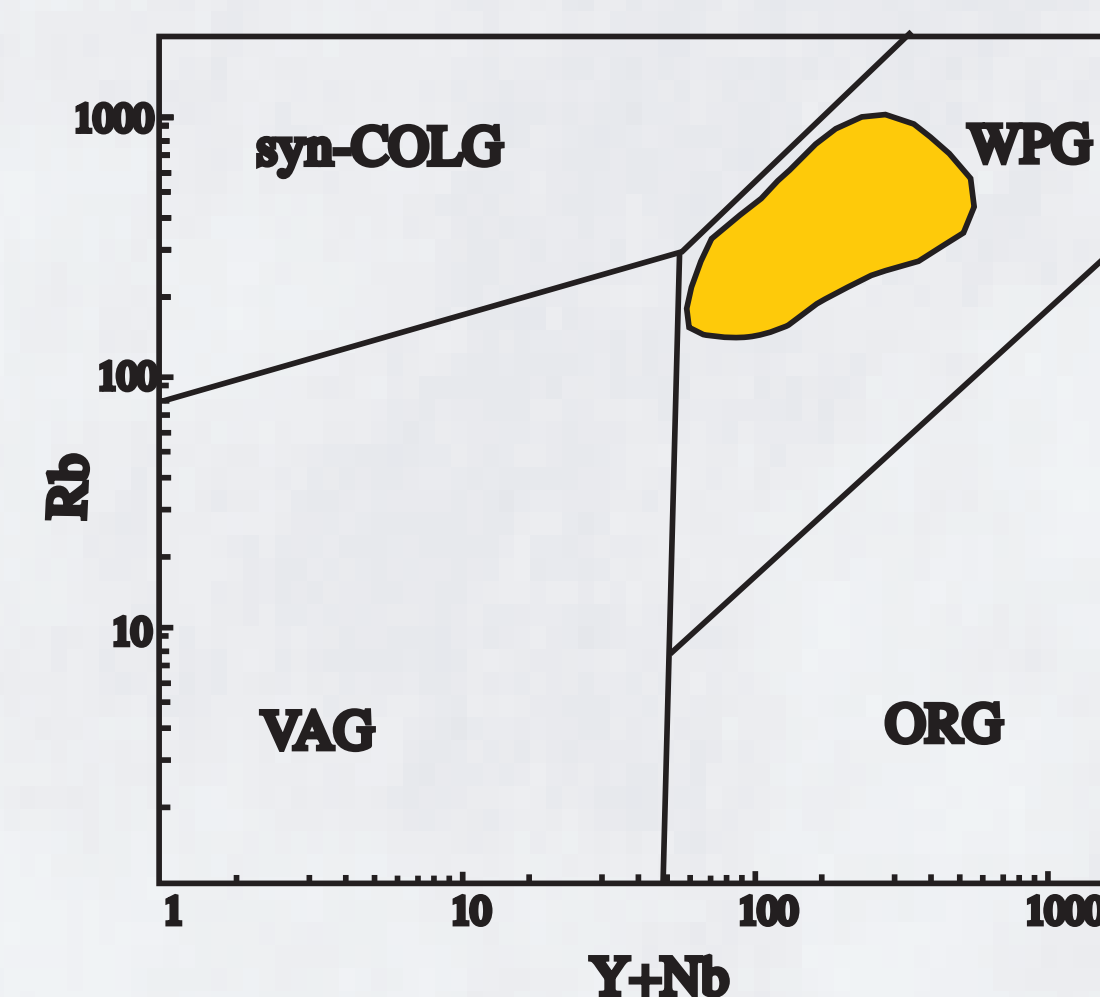
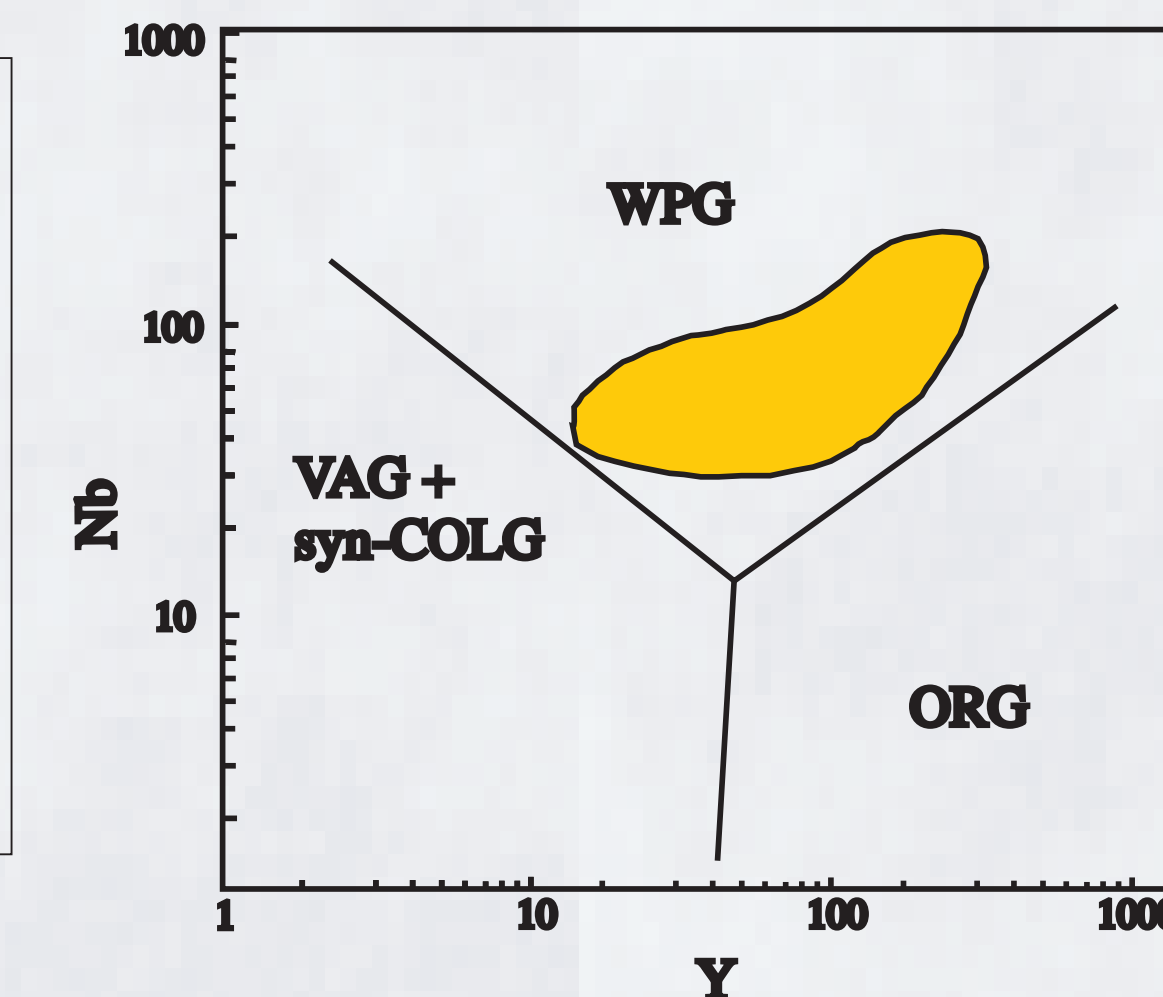
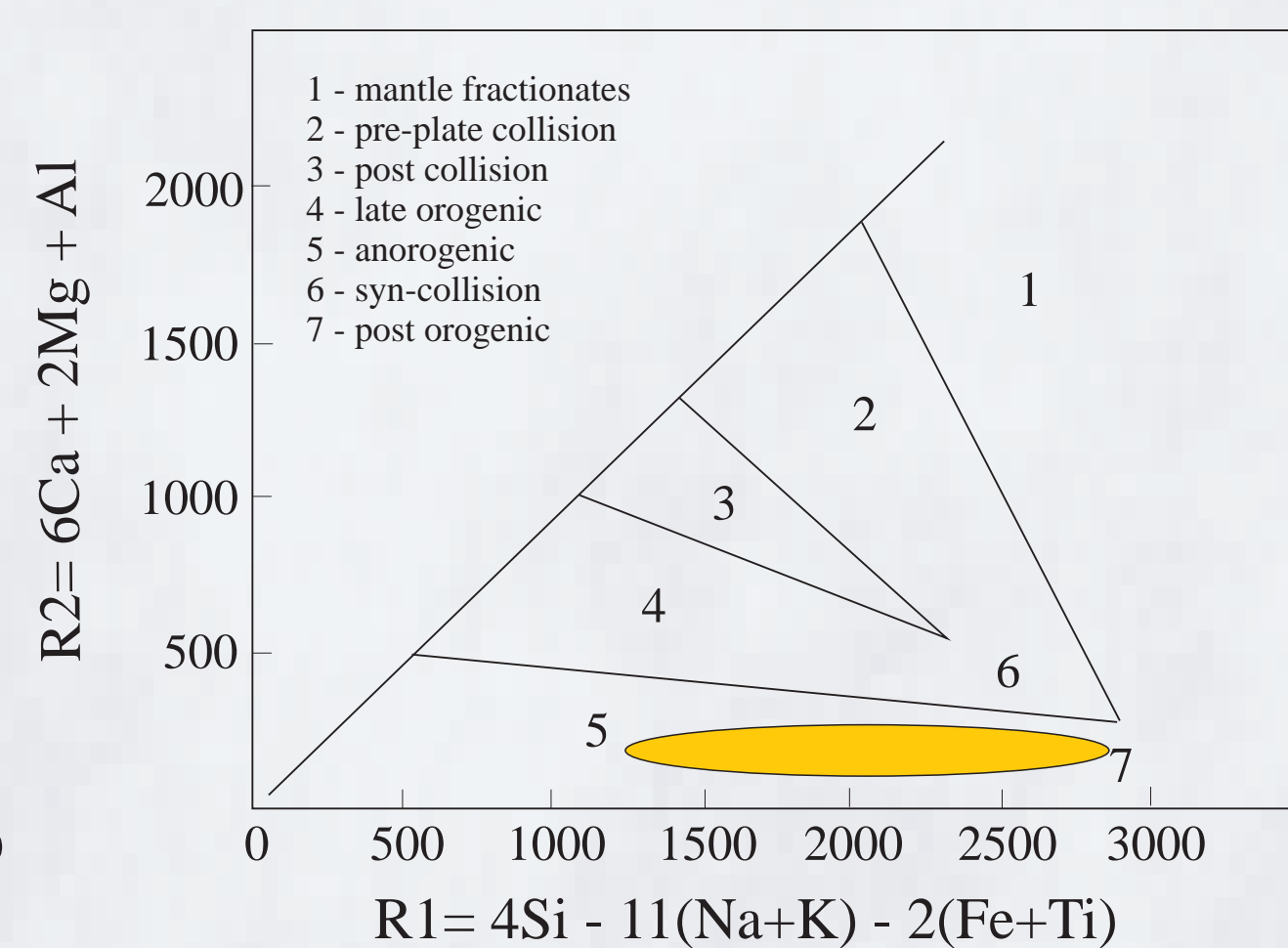


Peralkaline granite massifs: A - West Keivy; B - White Tundra. Gabbro-anorthosite massifs: C - Tsaga; D - Pike and Bear. E - Sakharyok nepheline syenite massif.

## Geochemistry of the rocks from the Keivy complex and tectonic discriminant diagrams



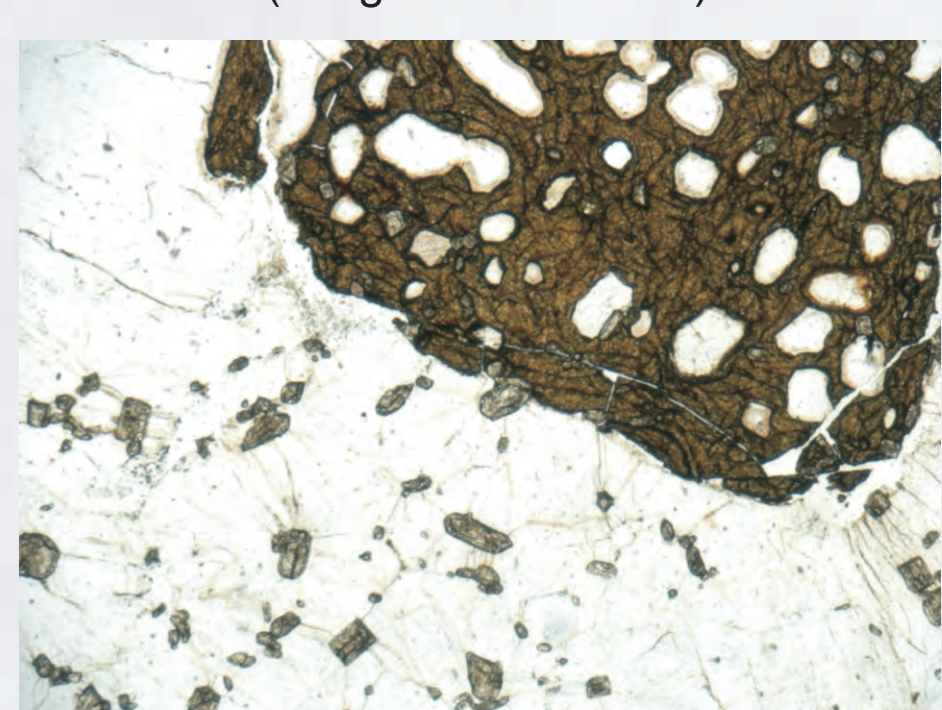
The rocks of the Keivy complex are extremely enriched in Zr (300-5000 ppm), Y (40-500 ppm), Nb (20-600 ppm), Rb (160-900 ppm), REE (100-1000 times chondrites), have associated Zr-REE ore occurrences, are very low in Sc (0.3-1.3 ppm) and Sr (10-30 ppm), and high Ga/Al ratios. On standard trace element discriminant diagrams of Whalen et al. (1987), Pearce et al. (1984), Eby (1990) the Keivy peralkaline granites plot as within-plate or post-collisional A-type granitoids. The low Y/Nb and Yb/Ta ratios for the associated nepheline syenite indicate an OIB affinity. The anorthosites show high compatible element (Sc, 25-40 ppm and Sr, 460-670 ppm) abundances and very low incompatible elements (Zr, 60-100 ppm, Y, 4-15 ppm, Nb, 8-12 ppm, Rb, 15-30 ppm), but the same Y/Nb, Ce/Nb, Yb/Nb ratios as the granites. The enriched source for the Keivy anorthosites has low eNd (-0.15 to -0.24) and low Y/Nb ratios (0.6-1.3). The least evolved syenogranites plot in the EM2-field on the eSr - eNd diagram.



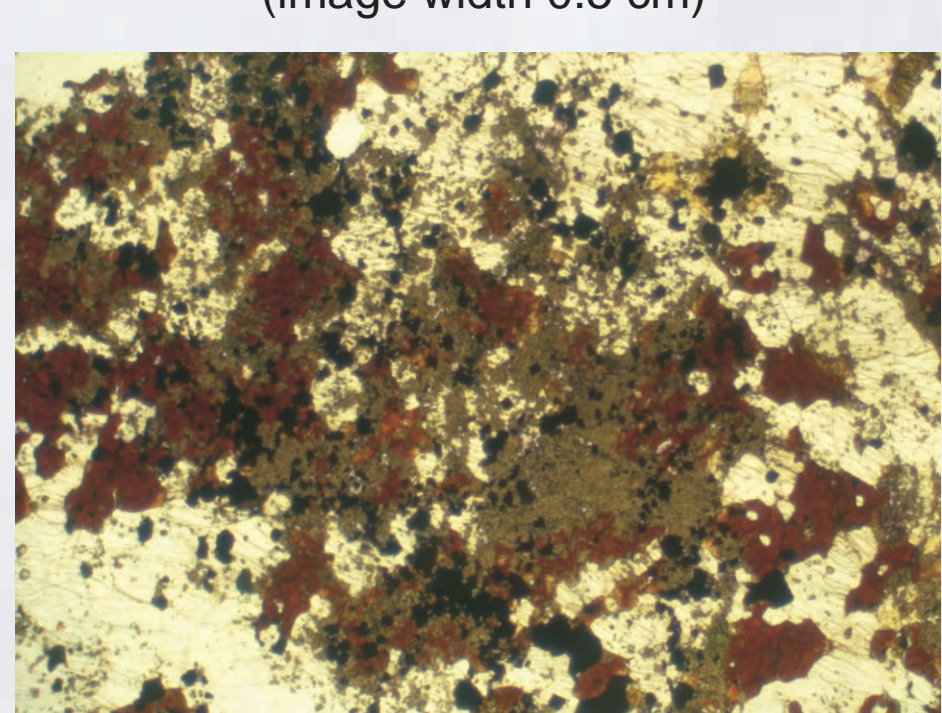
## Typology, geology, mineralogy and geochemical specialization of Keivy alkali granite rare-metal occurrences



Zircon in mineralised granite-I (image width 0.4 cm)

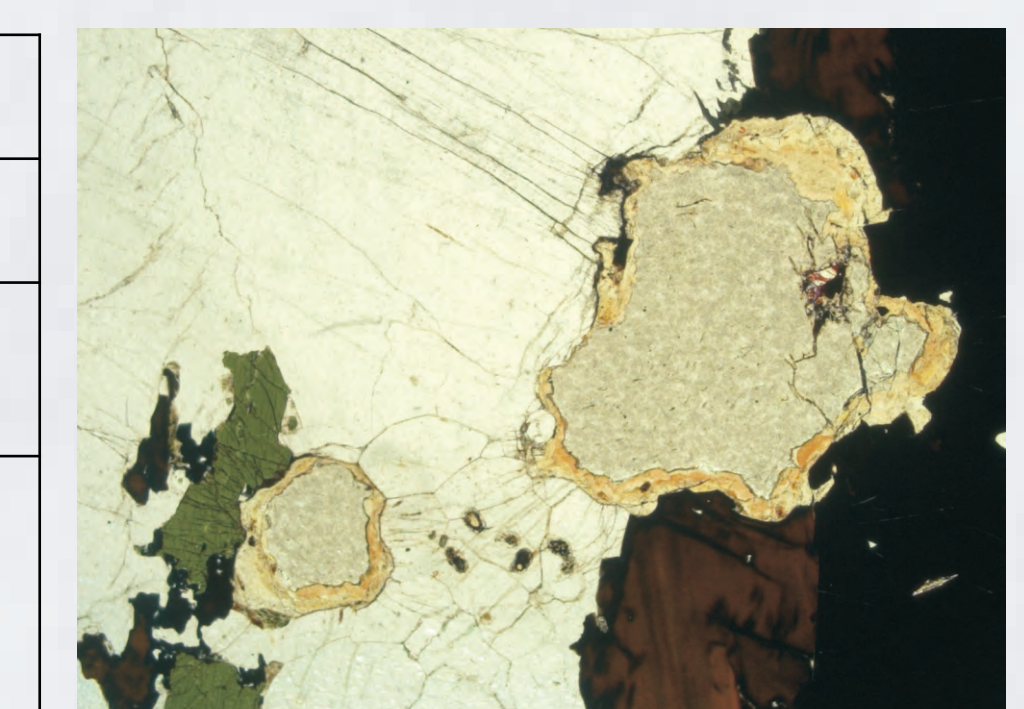


Aeshynite (Y) and zircon in albite (image width 0.5 cm)

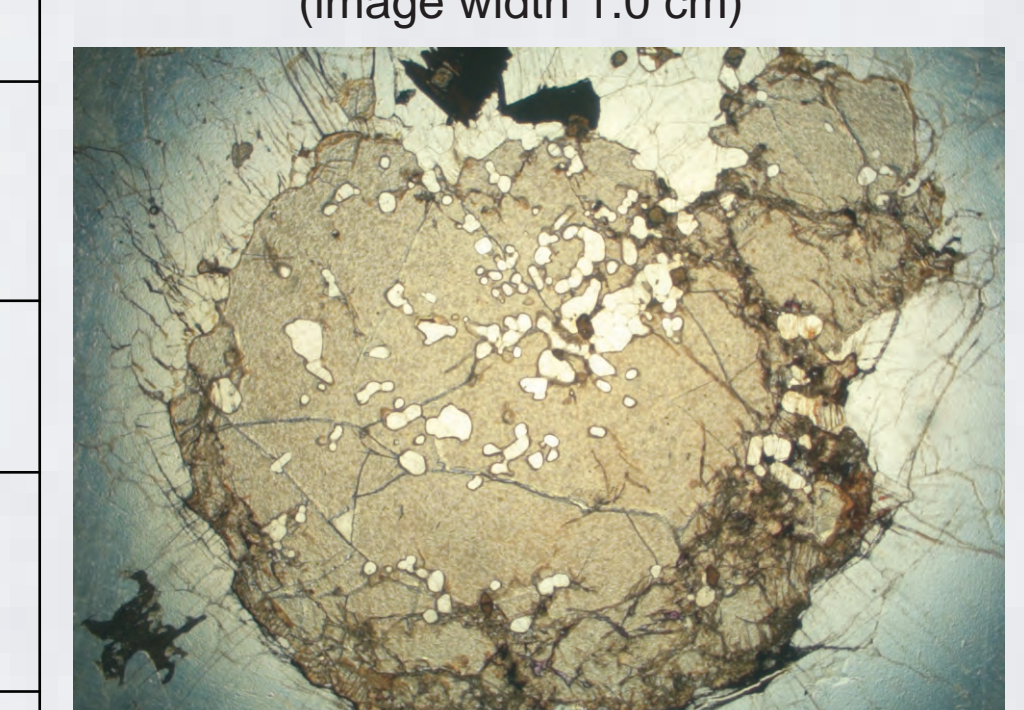


Chevkinite and zircon in silexite-II (image width 0.5 cm)

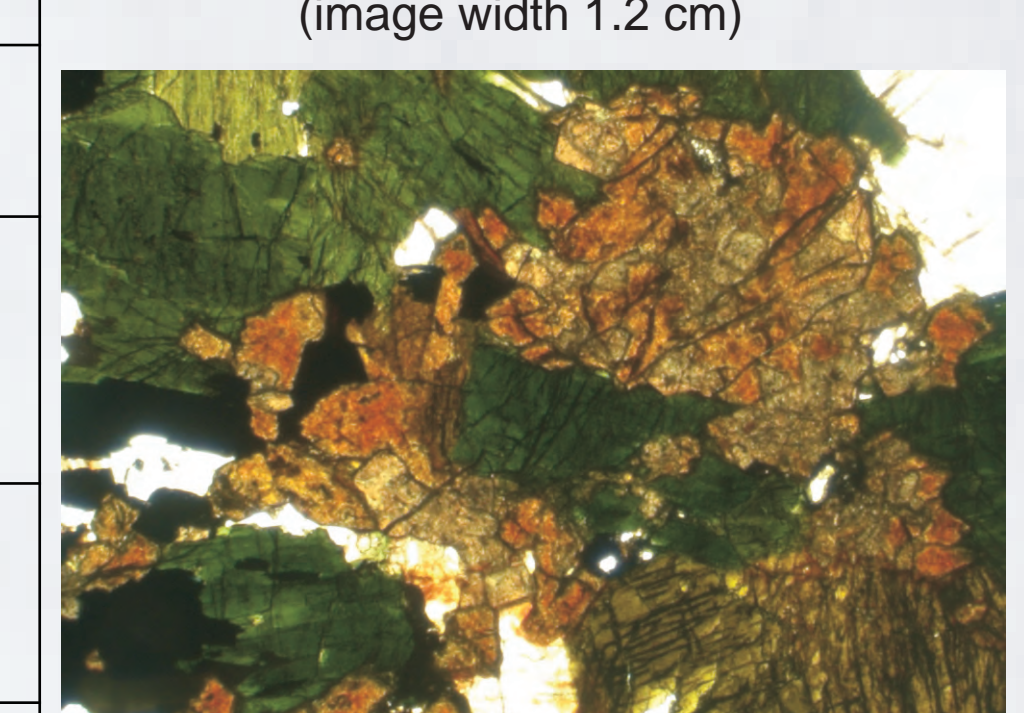
Genetic type	Geological position	Geological structure	Main rock-forming minerals	Rare-metal mineralization	Geochemical specialization and type by Cherny (1991)	Occurrence' symbol on the map
Mineralised granites-I	Apical parts of massifs	Lens-like bodies of few tens m thickness and up to 5 km length	Quartz, albite, microcline, magnetite, aegirine	Zircon, thorite, chevkinite, allanite, fergusonite, britholite-(Y), bastnäsite	Zr, Y, HREE, Th, Nb (Nb/Ta>15) NYF-type	□
Mineralised granites-II	Bottom parts of massifs	Bodies of irregular shape (10-100km <sup>2</sup> ), confined to tectonically fractured zones	Quartz, microcline, magnetite, chlorite, hematite	Zircon, thorite, fluorite, cassiterite, pyrochlore	Zr, REE, Th, Nb (Nb/Ta=8-10), Sn, Li, F NYF-LCT-type	○
Albitites	Exocontact zones	Isometric and irregular-shaped bodies (tens m <sup>2</sup> ) with gradual transition to country rocks; zonal structure: quartz core and albite outer zone	Quartz, albite, aegirine, arfvedsonite	Zircon, thorite, titanite, aeshynite-(Y), thalenite, britholite-(Y)	Zr, Y, HREE, Th, Nb (Nb/Ta=20), Ti NYF-type	◻
Microclinites	Bottom and inner parts of massifs	Irregular-shaped bodies (tens m <sup>2</sup> ) with gradual transition to country rocks with rare quartz cores	Microcline, quartz, protothionite	Zircon, thorite, pyrochlore-(W), cassiterite	Zr, REE, Th, Nb (Nb/Ta=8), Sn, W, Li NYF-LCT-type	◻
Apobasic metasomate	Contact zones of granites with basic rocks	Small irregular-shaped bodies of inhomogeneous structure; bear restites of mafic rocks	Quartz, albite, microcline, aegirine, arfvedsonite, ferrohastingsite, lepidomelane	Zircon, thorite, epidote-(REE), fergusonite, chevkinite, gadolinite, pyrochlore, fluorite, cassiterite, danalite, monacite	Zr, REE, Th, Nb (Nb/Ta=10-24), Sn, F, Be, W NYF-LCT or NYF-type	◻
Silexites-I	Exocontact zones	Small irregular-shaped bodies and veins (1-2 m); sharp contact to country rock; taxitic structure	Quartz, arfvedsonite, aegirine, ilmenite, lepidomelane, magnetite, albite	Zircon, fergusonite, britholite-(Y), chevkinite, bastnäsite, thorite, fluorite	Zr, Y, HREE, Nb (Nb/Ta=15-20), Th, Ti, F NYF-type	◻
Silexites-II	Endocontact zones	Small isometric and irregular-shaped bodies (up to 1 m); gradual transition to country granite; taxitic structure	Quartz, aegirine, arfvedsonite, magnetite, ilmenite, microcline	Zircon, fergusonite, britholite-(Y), chevkinite, yttrilite, thorite	Zr, Y, HREE, Nb (Nb/Ta>20), Th, Ti NYF-type	◻
Quartz-feldspar-astrophyllite pegmatites	Apical and inner parts of massifs	Vein-like bodies up to 10 m length with chambers; zonal pegmatitic structure	Quartz, microcline, arfvedsonite, albite	Astrophyllite, gadolinite	Y, HREE, Ti, Be NYF-type	◻
Quartz-microcline pegmatites	Contact zones	Vein-like bodies up to 30x10 m length of zonal pegmatitic structure	Quartz, microcline, magnetite, albite, aegirine	Fergusonite, chevkinite, britholite-(Y), aeshynite-(Y), gadolinite	Y, Nb (HREE, Be) NYF-type	◻
Amazonite pegmatites	Roof country rocks (gneiss of Keivy complex)	Large vein-like bodies up to few 100 m length of zonal pegmatitic structure	Amazonite, quartz, albite, lepidomelane	Microlite, betafite, pyrochlore-(W), keyvite, fluorite-(Y), xenotime, gadolinite, genthylvite, polyolithionite, kainosite, cassiterite, galena, molybdenite	Y, Yb, Nb, Ta, F, Li, Sn (Pb, W, Mo) NYF-LCT-type	◻
Hydrothermal veins	Apical parts of massifs and roof country rocks	Veins of up to several tens m length and 0.5 m thickness; sharp contact to country rocks	Quartz, riebeckite, microcline	Zircon, ilmenite, fluorite, astrophyllite	Zr, Ti, F NYF-type	◻
Mineralised nepheline syenites	Linear zones in magmatic body	Several steeply dipping linear zones of 200-1350 m length and of 3-30 m thickness	Nepheline, aegirine, microcline, albite, lepidomelane	Zircon, britholite-(Y), pyrochlore, fluorite, melaphanite, behoite	Zr, Y, REE, Nb, F, Be	◻



Britholite-(Y) in silexite-I (image width 1.0 cm)



Britholite-(Y) in silexite-I (image width 1.2 cm)



Fergusonite and zircon in silexite-I (image width 0.8 cm)