DISCOVERY OF POTENTIAL NEW MINERAL SPECIES IN THE PEGMATITE OF VARUTRÄSK, SWEDEN

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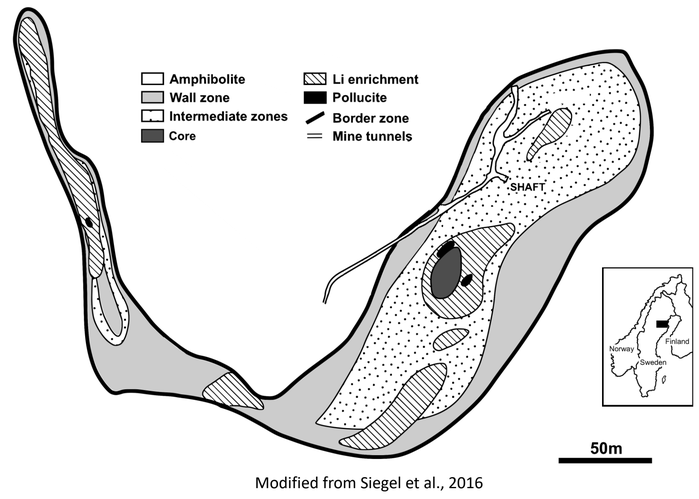
Introduction

- The **Varuträsk pegmatite,** northern Sweden**,** is a **well-zoned** and **extremely differentiated** pegmatite of the **petalite subtype**. This pegmatite is considered as a reference site for investigating **pegmatitic processes** due to its great mineralogical diversity, particularly in **phosphates**, silicates, and oxides,
- Phosphate minerals are **important pretrogenetic indicators** due to their relatively narrow stability fields compared to silicates. For this reason, phosphate assemblages, including minerals of the **alluaudite group**, have been reinvestigated.



Modified from Siegel et al., 2016

Chemical variations in minerals of the alluaudite group

Simplified structural formula

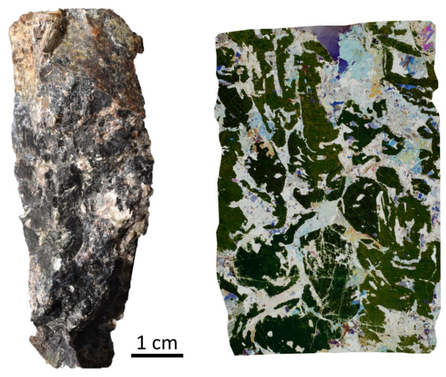
$A(2)'A(1)M(1)M(2)_2(TO_4)_3$

- $A(2)'$: Na, □, K
- $A(1)$: Na, Mn, Ca
- $M(1)$: Mn, Fe^{2+}
- $M(2)$: Fe^{3+}, Fe^{2+}, Mn, Mg, Li

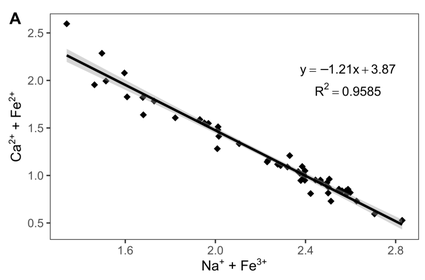
Mineral name	New ideal formula
Alluaudite	$\square NaMnFe^{3+}_2(PO_4)_3$
Ferroalluaudite	$\square NaFe^{2+}Fe^{3+}_2(PO_4)_3$
Hagendorfite	$Na_2MnFe^{2+}Fe^{3+}(PO_4)_3$
Maghagendorfite	$Na_2MgFe^{2+}Fe^{3+}(PO_4)_3$
Varulite	$Na_2Mn_2Fe^{3+}(PO_4)_3$

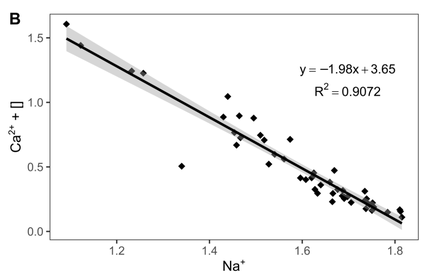
Hatert (2019)

Varulite from Varuträsk



1. Ca incorporation through coupled heterovalent substitution mechanisms

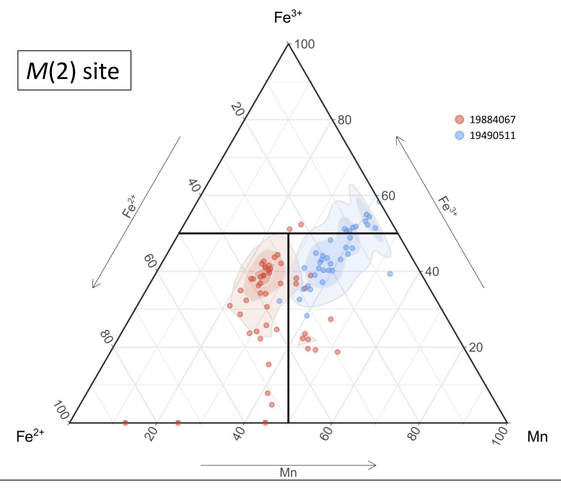




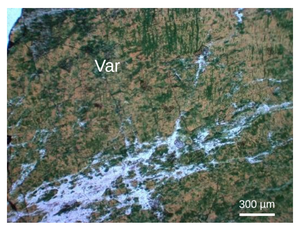
$^{A1}Na^+ + {}^{M2}Fe^{3+} \rightarrow {}^{A1}Ca^{2+} + {}^{M2}Fe^{2+}$

$^{A1}Na^+ + {}^{A2}Na^+ \rightarrow {}^{A1}Ca^{2+} + {}^{A2}[]$

2. Compositional variations from varulite toward hagendorfite



3. Oxydation mechanisms



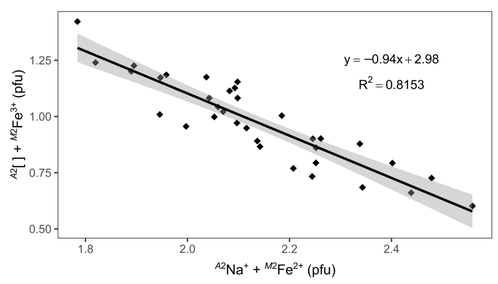
Varulite → alluaudite *s.s.*

$^{A2}Na^+ + {}^{M2}Fe^{2+} \rightarrow {}^{A2}[] + {}^{M2}Fe^{3+}$

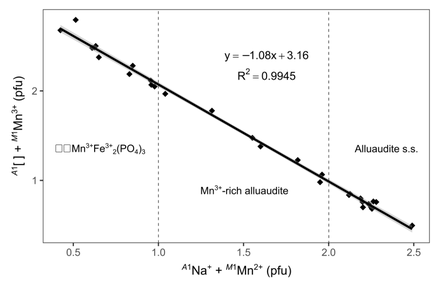
Alluaudite *s.s.* → $(\square\square Mn^{3+}Fe^{3+}_2(PO_4)_3)$

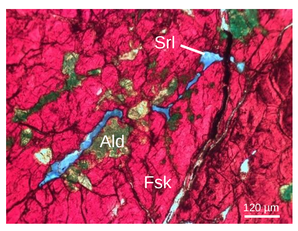
$^{A1}Na^+ + {}^{M1}Mn^{2+} \rightarrow {}^{A1}[] + {}^{M1}Mn^{3+}$

→ New charge-balanced end-member



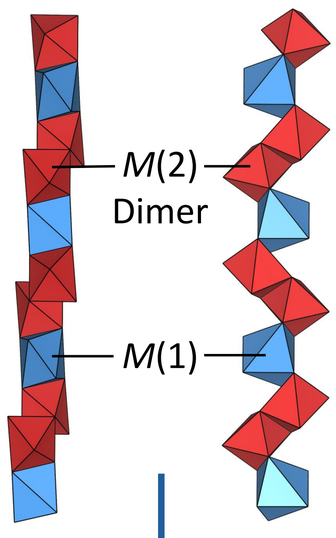
Increase of oxygen fugacity

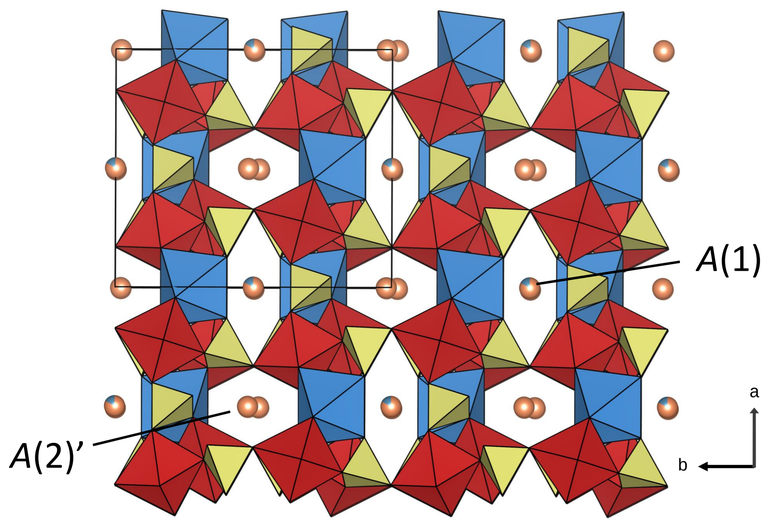




Alluaudite structure

Alluaudite is monoclinic, space group *C2/c*,
a = 12.004 (2), *b* = 12.533(4), *c* = 6.404(1) Å,
β = 114.4(1)





Chains of edge-sharing *M*(1) and *M*(2) octahedra parallel to the {101}

Chains are connected by TO_4 and form layers perpendicular to b axis

Two disticnt types of channels host the *A*(2)' and *A*(1) sites

Pb-caryinite

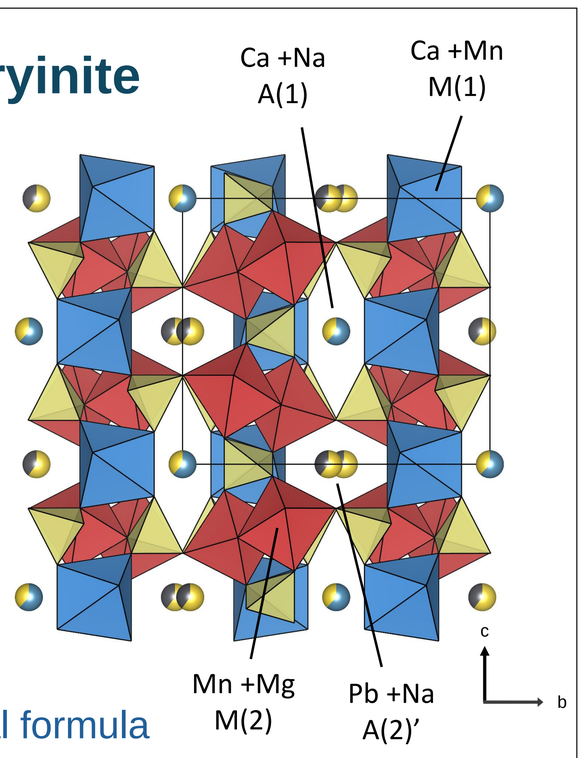
Caryinite

$NaCaCaMn_2(AsO_4)_3$

Isostrucutural with alluaudite

Space group : *I2/a*

a = 6.866(5) ; *b* = 13.178(7) ;
c = 11.53(7) Å, β = 98.771(6)



Empirical formula

$(Pb_{0.50}Na_{0.30}[]_{0.20})(Ca_{0.54}Na_{0.46})(Ca_{0.64}Mn_{0.36})(Mn_{1.46}Mg_{0.54})(AsO_4)_3$

Structural formula

$(Pb_{0.45}Na_{0.35}[]_{0.20})(Ca_{0.60}Na_{0.40})(Ca_{0.71}Mn_{0.29})(Mn_{1.32}Mg_{0.68})(AsO_4)_3$

→ $(Pb_{0.5}\square_{0.5})CaCaMn_2(AsO_4)_3$

→ New end-member of the alluaudite-type arsenates

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