The Role of Volatile Elements in Cancrinites from the Larvik Complex, Norway

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Introduction

Cancrinite-group minerals are important feldspathoids used as **microporous materials**. They possess zeolitic **cages** and large **channels** that incorporate various cations (Na^+, K^+, Ca^{2+}), anions (Cl^-, S^{2-}, F^-), anionic groups (CO_3^{2-}, SO_4^{2-}, OH^-, $C_2O_4^{2-}$, PO_4^{3-}), and neutral molecules (H_2O, CO_2)[1].

$$A_{7-8}[Al_{6-y}Si_{6+y}O_{24}]X_{1-4}\cdot nH_2O$$
$$y = 0-1.2 \quad n = 0-5$$

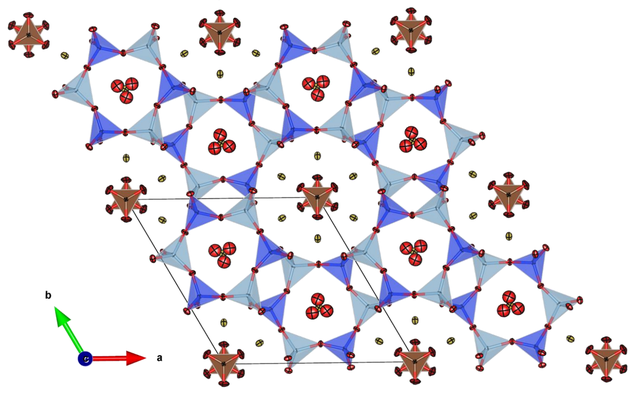

Fig 1: crystal structure of a cancrinite

They can be used as **petrogenetic indicators** in alkaline complexes[2].
There remains significant uncertainties about the role of volatiles in their structures[3].

Aims

- **Crystal-chemical study:** characterising the structure and chemical composition of cancrinites from the LPC.
- **Petrogenetic study:** highlighting the relationships between volatile content and paragenesis.

Sampling Sites

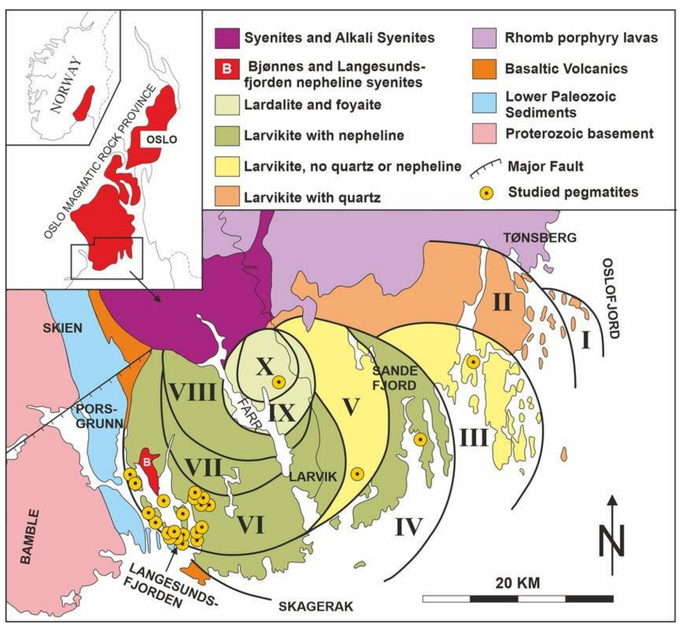

Fig 2: geology of the Larvik Plutonic Complex (LPC)[4]

- **16 cancrinites/vishnevites/cancrisilites** from various alkaline complexes (Cancrinite Hill, Blue Mountain, MSH, Litchfield, Khibiny, Ilmen Montains, *etc.*)
- **21 cancrinites** from Langesundsfjord nepheline syenite pegmatites[5] (LPC)

Analytical Methods

- **EMPA:** chemical compositions of cancrinites
  - Si, Al, Na, K, Ca, Fe, Mn, S, P, F, Cl, ~~CO_2~~, ~~H_2O~~
  - Na diffusion under the beam ☹
- **SCDRX:** crystal structures of cancrinites
  - Framework
  - *Can* cages
  - Wide channels
- **FTIR:** molecular groups
  - CO_2, CO_3^{2-}, $C_2O_4^{2-}$
  - H_2O
  - (SO_4^{2-})

Results & Discussions

I. EMPA

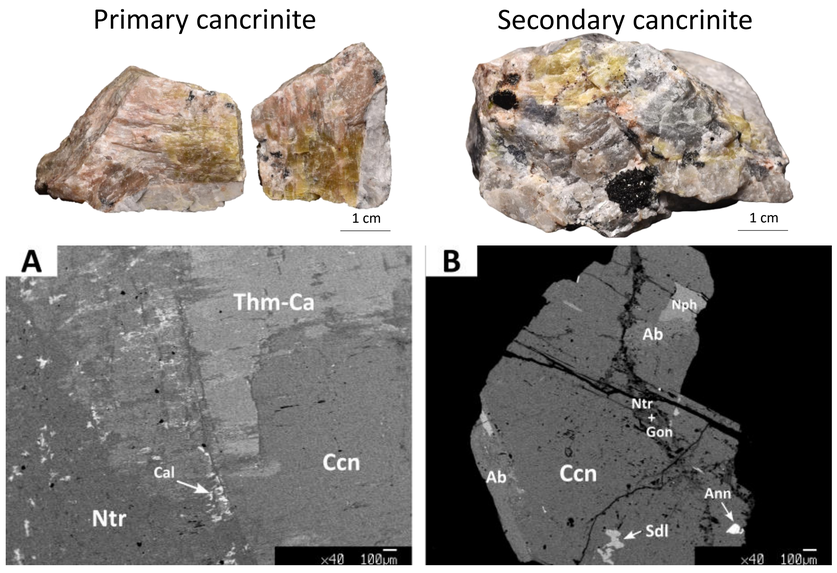

Fig 3: BSE images of primary (left) and secondary (right) cancrinites

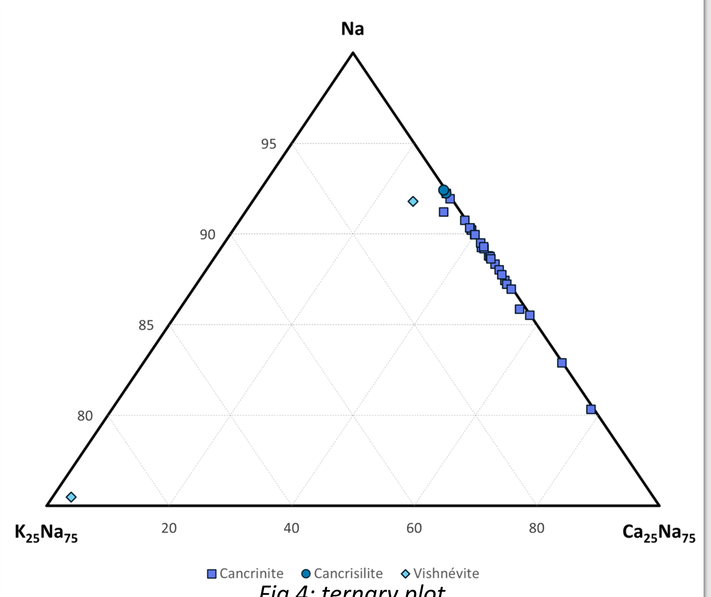

Fig 4: ternary plot

- Continuous solid solution cancrinite–cancrisilite: $Al_T^{3+} + Ca_{M2}^{2+} \leftrightarrow Si_T^{4+} + Na_{M2}^{+}$ ⇨ Cancrinites from LPC
- Continuous solid solution cancrinite–K-poor vishnevite: $Ca_{M2}^{2+} + (CO_3)_A^{2-} \leftrightarrow 2Na_{M2}^{+} + (SO_4)_A^{2-} + \square_A$

II. SCXRD

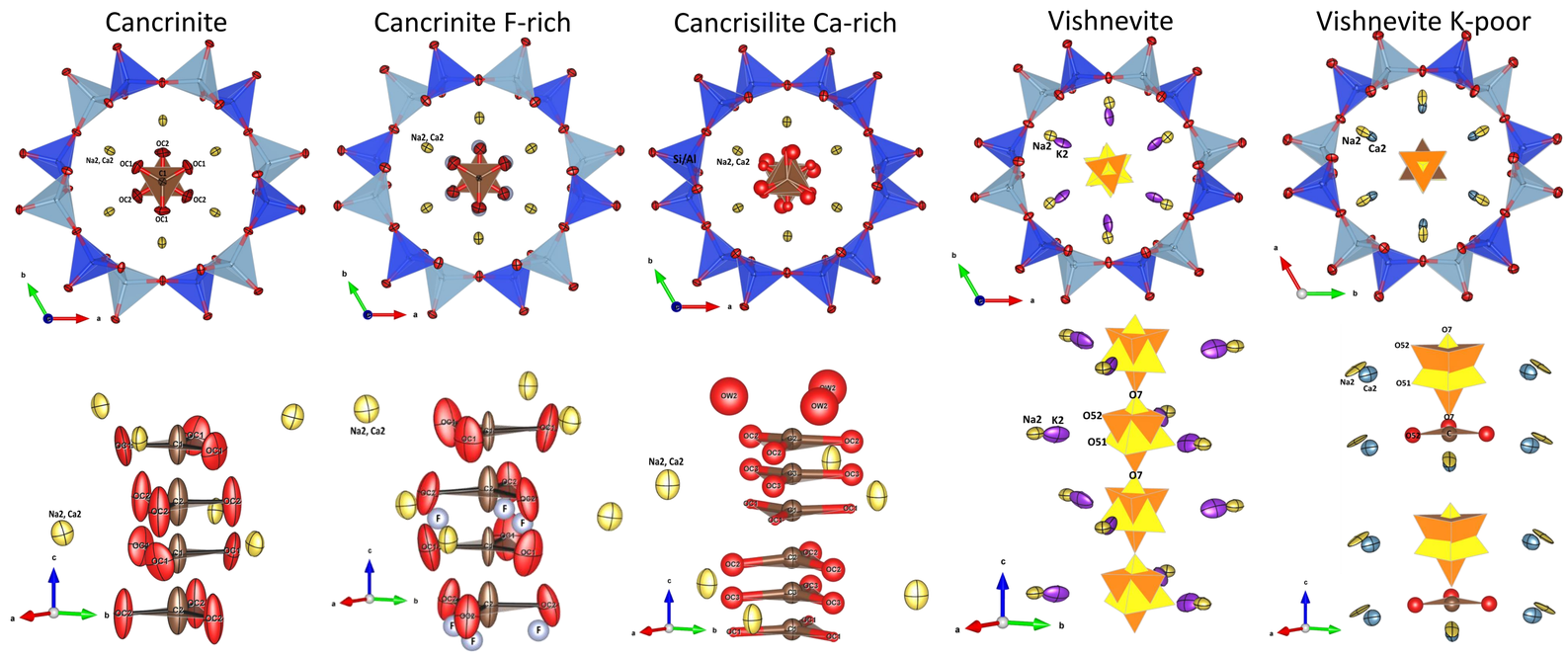

Fig 5: channel contents of cancrinites (left), cancrisilite (middle), and vishnevites (right)

III. FTIR

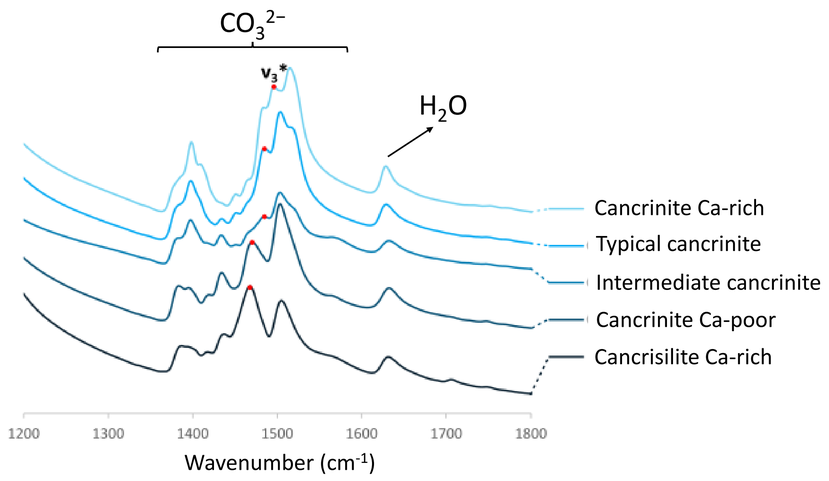

*Fig 6: Migration of v3** peaks in the cancrinite–cancrisilite series

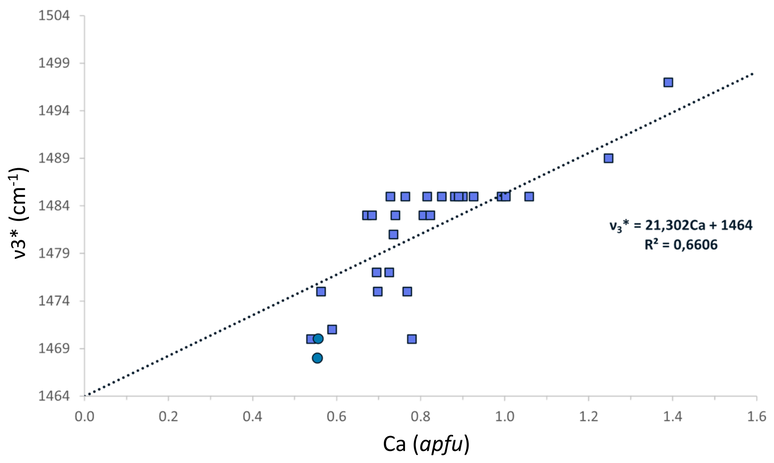

Fig 7: Correlation between v3 wavenumber* and Ca content

- Six cancrinite subtypes can be distinguished on the cancrinite–cancrisilite series with their IR-spectra
- This distinction has petrogenetic significance as the six subtypes form under different alkalinity conditions

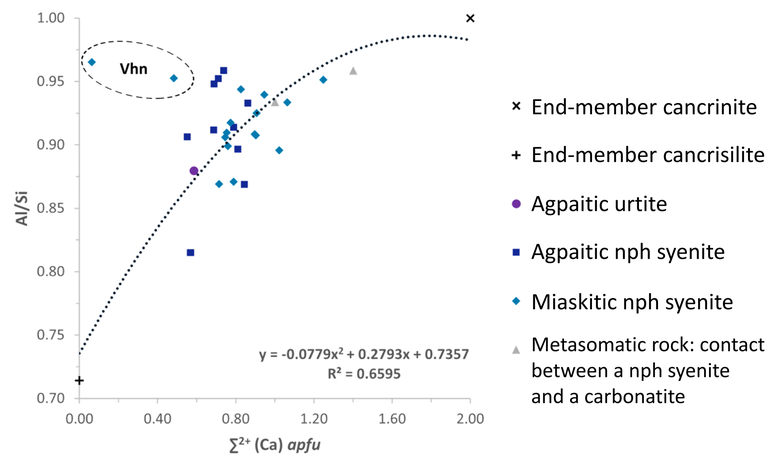

Fig 8: divalent cations against the Al/Si ratio in cancrinite-group minerals

Conclusion & Outlook

- IR spectroscopy is essential for the analysis of cancrinite-group minerals
- Cancrinite-group minerals can be used as petrogenetic indicators in alkaline complexes
- Potential use of cancrinite–cancrisilite series to estimate miaskitic–agpaitic conditions

Further implications:
- Probable new species of fluorcancrinite

References

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