

THE CRYSTAL-CHEMISTRY AND PETROLOGY OF TWO NEW MINERALS
IN THE SYSTEM ANORTHITE-NEPHELINE

by

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This lecture describes the results of a research project carried out recently in collaboration with Dr. S.A. Kechid (Paris), and Dr. R. Oberti and Prof. Dr. G. Rossi (Pavia). It concerns two new minerals, abbreviated here by the symbols Lt and Ln, which occur in the 60 m x 30 m eclogite pod (lens) at Liset in the Western Gneiss Region of southern Norway. Like in many eclogite pods in this region, all transitions between fresh preserved eclogite-facies parageneses (>20 to >30 kbar) and completely retrogressed parageneses (amphibolite- or greenschist-facies, 15-5 kbar) occur.

Lt and Ln only occur in strongly retrogressed layers which previously contained abundant clinopyroxene (jadeite or omphacite) and minor garnet + quartz + paragonite + rutile + ilmenite and possibly + kyanite (at $P > 20$ kbar at $T \sim 700^\circ \text{C.}$); these rocks are now composed mainly of plagioclase + magnesio- (or ferro-)aluminotaramite after clinopyroxene, magnetite + taramite after garnet, corundum + plagioclase after paragonite and aegirine + hematite surrounding relict quartz. Lt occurs in clusters surrounded by a polycrystalline zone of Ln which is itself isolated from the rest of the rock by a corona of taramite.

Lt and Ln have no form, twinning, cleavage or colour. Their refractive indices and birefringences are approximately the same as respectively calcic-plagioclase and KNa_3 -nepheline with which they may be easily confused.

Lt has compositions very close to the end-member formula $\text{CaNa}_2\text{Al}_4\text{Si}_4\text{O}_{16}$ which is identical to a combination of 50 mol. % anorthite (An) and 50 mol. % NaNa_3 -nepheline (Ne); however structurally it is neither a feldspar nor a feldspathoid. Ln has compositions close to the end-member formula $\text{Ca}_0.5\text{Na}_3\text{Al}_4\text{Si}_4\text{O}_{16}$ which is identical to $\text{An}_{25}\text{Ne}_{75}$. However most Ln compositions are poorer in An (down to 15 mol. % An) and contain excess Si which represents a little of the vacancy substitution well-known in feldspathoids: $\text{Na} + \text{Al} = \square + \text{Si}$.

Ln has the same structure, atomic coordinates and ordering as KNa_3 -nepheline except for the K site which on average contains ~ 0.5 vacancy, ~ 0.375 Ca in the normal K position, and ~ 0.125 Ca in a new position displaced 1.6 Å to the side in order to gain a better coordination.

Lt has an orthorhombic tectosilicate structure with a highly ordered Al-Si distribution, 6-fold Na sites (more compact than in albite) and 7-9-fold Ca sites. Lt is similar to the feldspar structure but instead of having UDD rings, it has UDUD rings (U = upwards-pointing tetrahedron apex, D = downwards). Lt is more similar to banalsite $\text{BaNa}_2\text{Al}_4\text{Si}_4\text{O}_{16}$ which also has UDUD rings. However whilst banalsite has alternating cation layers of Ba_2 or Na_4 compositions, Lt has CaNa_2 in all layers.

The tetrahedral rather than octahedral nature of Al in both Lt and Ln suggests a stability at relatively low P and/or high T conditions, cf. feldspars and feldspathoids, which fits with their occurrence in strongly-retrogressed eclogites.

However the density of Lt exceeds the mean density of An and Ne which implies a higher P and/or lower T origin than the stability of an An + Ne mineral pair.

The petrological details of the development of Lt and Ln are not yet clear but there are several lines of evidence to indicate that Lt was formed by the dehydration and very localised Na + Ca metasomatism of either paragonite or of the corundum + plagioclase symplectite after paragonite. Ln formed contemporaneously with or later than Lt by further localised Na metasomatism, being isolated from nearby relict quartz by a zone of plagioclase. The source of the Na and the dehydration are adequately explained by the breakdown of nearby jadeite into plagioclase + taramite such that the bulk-rock retrogression may have been largely isochemical; a further characteristic of the retrogression seems to have been a relative immobility of the Al-Si-O distribution with only low-charge cations diffusing significantly since paragonite shares the same $Al_4Si_4O_{16}$ ratio as both Lt and Ln and also An and Ne.

Lt and Ln probably formed at 10-15 kbar at 500-700° C and their existence is largely due to the original extreme Na-Al-rich and K-Mg-poor bulk-rock composition of the clinopyroxene layers at Liset. These minerals might thus be expected to develop in certain paragonite + jadeite blueschists or nepheline-rich alkaline igneous rocks subjected to similar P-T conditions.