Feldspars and feldspathoids II: the common feldspars

Feldspars are tectosilicate minerals in which a 3+ cation substitutes for Si^{4+} in a quarter to a half of the tetrahedral sites. This page explores the minerals in which Al^{3+} is that 3+ cation, and in which the more abundant 1+ and 2+ cations (Na^+ , K^+, and Ca^{2+}) supply the positive charge left unbalanced by 3+-for-4+ tetrahedral substitution.

Let's begin with the chemical formula for quartz, the most familiar silica mineral. SiO_2

Let's quadruple that formula. Si_4O_8

Common Feldspars
Rare feldspars

Li^+	Be^{2+}	B^{3+}	C^{4+}
Na^+	Mg^{2+}	Al^{3+}	Si^{4+}
K^+	**Ca^{2+}**	Sc^{3+}	Ti^{4+}
Rb^+	Sr^{2+}		
Cs^+	Ba^{2+}		

Bearing in mind that Al^{3+} is an abundant cation near in size to Si^{4+}, let's substitute one Al^{3+} for one of the Si^{4+}. $[AlSi_3O_8]^-$

The geometry of the tectosilicate structure will allow a second interation of this substitution, to give the unbalanced formula at left. $[Al_2Si_2O_8]^{2-}$

The substitution above results in an imbalance of charge, because we substituted a 3+ cation for a 4+ cation. The interstices of the Al-Si-O network will accomodate 1+ cations like Na^+ and its larger pal K^+, so we can for example write the chemical formulae of these alkali feldspars:

Charge balance:

$(1-x) + (2x) + (3 + 3x) + (12-4x) = 16 \quad 2 \cdot 8 = 16$

$NaAlSi_3O_8$ **Albite**

and

$KAlSi_3O_8$ **Sanidine Orthoclase Microcline**

$Na_{1-x}Ca_xAl_{1+x}Si_{3-x}O_8$ **Plagioclase feldspars**

$CaAl_2Si_2O_8$ **Anorthite**

There is an essentially complete solid solution between albite and anorthite – a full range of compositional intermediates. Charge balance requires paired substitution: increasing substitution of Al^{3+} for Si^{4+} in tetrahedral sites must be balanced by substitution of Ca^{2+} for Na^+ to maintain charge balance.

In this solid solution series, the intermediate feldspars, and the two end members (albite and anorthite) are called "plagioclase feldspars". Albite is thus considered both an alkali feldspar and a plagioclase feldpsar.

Ca^{2+} is the most abundant 2+ cation of sufficiently low ionic potential that it can be tolerated in a structure with so much Si^{4+}, and so we can write the formula for anorthite at left.