Feldspars and feldspathoids I: Tetrahedral substitutions

The feldspars are among Earth's most abundant minerals and make up a large proportion of the crust. Feldspars are tectosilicates: minerals in which Si^{4+} and its substitutes share all four tetrahedral O^{2-}s with other tetrahedra to make three-dimensional frameworks. This page begins an exploration of the feldspars by going through the simple algebra of feldspar chemical formulae.

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

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+}.

$[AlSi_3O_8]^-$

B^{3+} is an analog of Al^{3+} but is much less abundant than Al^{3+}. It substitutes for Si^{4+} to form rare feldspars.

$[BSi_3O_8]^-$

$M^+ [BSi_3O_8]^-$

$M^+ [AlSi_3O_8]^-$

The unbalanced formulae in brackets can have their charge balanced by 1+ and 2+ cations to give these generic mineral formulae.

The geometry of the tectosilicate structure will allow a second interation of these substitutions, to give the unbalanced formulae at left and right.

$[Al_2Si_2O_8]^{2-}$

$[B_2Si_2O_8]^{2-}$

$M^{2+} [Al_2Si_2O_8]^{2-}$

$M^{2+} [B_2Si_2O_8]^{2-}$

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+}			

This side of the diagram is the subject of Parts II and III of this series.

This side of the diagram is the subject of Part IV of this series.