AKFM diagram

AKFM Projection onto AFM

The ACF and AKF diagrams discussed so far, are fairly simple, but useful. One of the problems associated with ACF and AKF diagrams is that Fe and Mg are assumed to substitute for one another and act as a single component. We know, however, that in natural minerals the composition of Fe - Mg solid solutions is very much dependent on temperature and pressure. Thus, in treating Fe and Mg as a single component, we lose some information. Realizing this, J.B. Thompson developed a projected diagram that takes into account possible variation in the Mg/(Mg+Fe) ratios in ferromagnesium minerals, and has proven very useful in understanding metamorphosed pelitic sediments.

Thompson starts with the 5 component system SiO2- Al2O3- K2O - FeO - MgO and ignores minor components in pelitic rocks like CaO and Na2O. Because quartz is a ubiquitous phase in metamorphosed pelitic rocks, the five component system is projected into the four component system Al 2O3- K2O - FeO - MgO as shown below.

Because muscovite is also a common mineral in these rocks, all compositions are projected from muscovite onto the front face of the diagram. (Al 2O3- FeO - MgO). The front face of the diagram becomes the AFM diagram.
Minerals that contain no K$_2$O like andalusite, kyanite and sillimanite plot at the A corner of the diagram, and minerals like staurolite, chloritoid (Ctd), chlorite, and garnet plot on the front face of the diagram.

Biotite, however, does contain K$_2$O and has varying amounts of Al$_2$O$_3$ and thus is a solid solution that lies in the four component system. Because muscovite is relatively K-poor, this results in biotite being projected to negative values of Al 2O$_3$.

Any rock composition, like composition a, shown in the diagram, will also project to the front face, and may or may not plot at negative values of Al 2O$_3$.

To calculate the plotting parameters for the AFM diagram the following formulae are used:

\[ A = [Al_{2}O_{3} - 3 K 2O] \]
\[ F = [FeO] \]
\[ M = [MgO] \]

Using these parameters, one can grid off the AFM diagram with the vertical scale represented by the normalized values for the A parameter -

\[ [Al_{2}O_{3} - 3 K 2O]/[Al_{2}O_{3} - 3 K 2O + FeO + MgO] \]

and the horizontal position based on the ratio of MgO/(FeO + Mg). as seen below. Of course these values are obtained after converting the chemical analysis of the rock to molecular proportions.

Note that if we project K-spar from muscovite, that the arrow points toward the K corner of the 4 component tetrahedron, and thus K-spar would project away from the front face of the diagram. Thus, as seen on the AFM face, K-spar would plot at negative infinity.

The projection from muscovite works well for metamorphic rocks that contain muscovite. But, at higher grades of metamorphism, in the upper amphibolite facies and the granulite facies, muscovite becomes unstable and is replaced by K-feldspar + quartz + an Al 2SiO 5 mineral. In order to show rocks and mineral assemblages at these higher grades of metamorphism, a new projection is made from K-spar, as shown below.

For this diagram the plotting parameters are much more straightforward, with -

\[ A = [Al_{2}O_{3}] \]
\[ F = [FeO] \]
\[ M = [MgO] \]

All on a molecular basis and then renormalized to sum to 100%.

Note the absence of all hydrous phases (staurolite, chloritoid, muscovite) except biotite in this projection.
AKFM diagram

[Diagram showing mineral distributions on a triangular graph with labels for Andalusite, Kyanite, Sillimanite, Staurolite, Chloritoid, Garnet, Chlorite, Biotite, and K-spar]