Relations between the norm and its variations, and the mode

C.S. Hutchison, Jabatan Geologi, Universiti Malaya, Kuala Lumpur

The C.I.P.W. norm is an expression of the chemical analysis of a rock in terms of the weight % of the normative minerals. It is more commonly used by North American petrologists. The Niggli catanorm is an expression in terms of cation proportions of the same minerals. Both norms of the same rock will contain identical minerals, but in varying amounts because of the differences in allocation procedures.

The oxide % is converted to a molecular proportion by dividing by the oxide formula weight (C.I.P.W.) or by the oxide equivalent molecular weight (Catanorm). The divisors are identical for single cation oxides (eg SiO_2), but different for others (e.g. C.I.P.W. Fe_2O_3, K_2O = Catanorm $FeO_{1\frac{1}{2}}$, $KO_{\frac{1}{2}}$). Allocations in C.I.P.W. are oxide based, e.g. 1 orthoclase = either $1(K_2O)$, or $1(Al_2O_3)$ or $6(SiO_2)$, whereas in the catanorm 1 orthoclase = either $5(KO_{\frac{1}{2}})$, or $5(AlO_{1\frac{1}{2}})$ or 5/3 (SiO_2), because 1 orthoclase contains 5 cations. The C.I.P.W. norm procedure ends by multiplying each mineral amount by its oxide-based molecular weight (e.g. quartz 60.08, orthoclase 556.64).

Based on these procedural differences, a table of factors have been calculated for conversion from C.I.P.W. to Catanorm: CATANORM amount = C.I.P.W. amount divided by $\frac{\text{catanorm molecular weight}}{\text{number of cations}}$

All conversion factors have been multiplied by a constant ($= \frac{5}{278.32}$) because it has been found that orthoclase calculated by either the C.I.P.W. or the Catanorm are always closely similar in amounts. This makes all conversion factors close to unity. An example of a conversion factor for albite = $NaO_{\frac{1}{2}}.AlO_{1\frac{1}{2}}.3SiO_2$ =

$$\frac{30.99 + 50.98 + 3(60.08)}{5} \times \frac{5}{278.32} = .942$$

The Volume Norm (= mode). To convert from C.I.P.W. to Volume Norm, divide the C.I.P.W. mineral amount by $\frac{\text{the mineral specific gravity}}{\text{the specific gravity of orthoclase}}$. After all conversions, the norm has to be pro-rated to 100%

The Mesonorm of Barth is like the Catanorm, but incorporates BIOTITE and HORNBLENDE. It is more useful for acid to intermediate igneous rocks and for meta-igneous rocks where biotite and hornblende are more appropriate than hypersthene and diopside.

The C.I.P.W. and Catanorms are really only ideal for basic igneous rocks.

FORTRAN IV computer programmes for C.I.P.W., Catanorm, and Mesonorm calculations and complete lists of the conversion factors between the three norms are available from the author.