THE "SHAND" DIAGRAM, A POSSIBLE SUBSILICIC PROTONATED GARNET, AND A POTENTIAL NEW UHPM END-MEMBER: "SUBSILIGAR"

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A most effective way of examining the stoichiometry of garnet and pyroxenes is the SAND diagram (Smith, 1982, 1988), initially devised by Smith (1976) for forcing jadeite to plot with diopside when dealing with eclogite-facies mineral and bulk-rock compositions. This plot takes advantage of the extreme mathematical constraint provided by all perfectly stoichiometric garnets $X_3Y_2Z_3O_{12}$ and pyroxenes $X_4Z_4O_{12}$, namely that they all have the same formula R_8O_{12} where R = any cation excepting H^+ On a linear plot of (ND) $vs.$ S they all plot at the same point at the centre. In the SA(ND) triangle with A at the apex, they all plot on the same line between diopside and corundum (the "Gt-Px line", or "R_8O_{12} line"), with all non-majoritic garnets (Gt) exactly at the half-way position between all "Tschermak's molecule" (Ts) pyroxenes and all non-Tschermak pyroxenes (Px). The diagram is updated here to include all elements, especially P^{5+}, Zr^{4+} Ti^{4+} V^{3+}, Mn^{3+}, Ni^{2+}, K^+, Li^+ & H^+ (because of the last it is renamed here the SHAND plot):

S (for Si $et\ al.$) = R^{4+} + R^{5+} (e.g. Si^{4+} + Ti^{4+} + P^{5+}),

H (for H only) = H^+,

A (for Al $et\ al.$) = R^{3+} - $[R^+ - R^{5+}]$ (e.g. Al^{3+} + Cr^{3+} + Mn^{3+} + Fe^{3+} - $[Na^+ + K^+ + Li^+ - P^{5+}]$),

N (for Na $et\ al.$) = $2•[R^+ - R^{5+}]$ + R^{5+} (e.g. $2•[Na^+ + K^+ + Li^+ - P^{5+}]$ + P^{5+}),

D (for divalents) = Ca^{2+} + Mg^{2+} + Mn^{2+} + Fe^{2+} + Ni^{2+}

(ND) = N + D;   all in cation proportions on the basis of O = 12.

The special point Px is very constrained as $R^+ = R^{3+}$, $R^+ + R^{3+} = R^{2+}$ and $R^+ + R^{2+} + R^{3+} = R^{4+} + R^{5+}$ It is more difficult to conceive of a supersilicic (S > ND) garnet than the supersilicic pyroxene "supersilipyx" $\{^{viii}\#\ ^{vi}Si\ ^{iv}Si_2\ O_6\}$ (where # = vacancy) proposed by Smith (2005, this conference). The replacement of Si by AlH or MgH_2 was also suggested there (i.e. a substitution mechanism very different from that in hydrogarnet where Si = H_4) as a way of creating subsilicic pyroxene or garnet ((S < ND) as in forsterite, periclase & spinel). By placing Si in the octahedra, majoritic garnet neatly provides a way of creating subsilicic garnet, especially by the substitution of $^{vi}R^{4+}$ by $^{vi}R^{2+}H^+_2$ such that some octahedra are not $R^{2+}O_6$ but $R^{2+}O_4(OH)_2$ as in tri-octahedral micas. If one operates the Si = MgH_2 substitution on pure majorite in both octahedral and tetrahedral sites, the following formula is obtained: $^{xii}Mg_3\ ^{vi}Mg_2H_2\ ^{iv}Si_2\ ^{vi}MgH_2\ O_{12}$ = $Mg_6Si_2O_{12}H_4$ = serpentine + 3•periclase = 2•forsterite + 2•brucite = the composition of norbergite. This garnet is called here "subsiligar" It follows that with the Si = MgH_2 substitution, one can create a subsilicic garnet with the composition: $^{xii}(Mg_{3p+3q+3r})\ ^{vi}(Mg_{q+r}\ H_{2r}\ Al_{2p}\ Si_q)\ ^{iv}(Mg_r\ H_{2r}\ Si_{3p+3q+2r})\ O_{12}$

= (p pyrope + q majorite + r norbergite) where ($p+q+r$) = 1 or 100 %. Such an UHPM garnet could exsolve enstatite from the majoritic component and also norbergite, or serpentine + periclase, or forsterite + brucite, or these potential species could combine in a different way (e.g. to exsolve chondrodite, humite or clinohumite).