Table 2 Calculated Gibbs Free Energy of Silicate Melts for Natural Rocks

Rock and mol fraction	Callander Bay Bulk rock		Ocellus (0.15)		Matrix (0.85)		Mont St Hilaire Homogeneous		Syenite (0.5)		Diorite (0.5)	
S_1O_2	40.26	24.22	53.51	30.30	38.96	23.14	52.29	30.57	53.95	31.27	50.66	29.88
Al_2O_3	15.48	11.12	21.62	14.41	14.76	10.33	20.03	13.81	19.03	13.00	21.01	14.61
T_1O_2	3.95	1.81	0.69	0.29	4.27	1.91	1.38	0.61	1.17	0.51	1.58	0.70
Fe_2O_3	6.23	2.86	2.01	0.81	6.53	2.75	2.95	1.30	4.70	2.05	1.24	0.55
FeO	6.56	3.34	2.08	0.94	6.93	3.26	2.56	1.25	2.02	0.98	3.08	1.52
MgO	5.29	4.81	2.23	1.85	5.60	4.96	1.09	0.95	0.60	0.52	1.57	1.38
CaO	10.28	6.72	1.27	0.79	1.66	7.42	3.75	2.35	1.26	0.78	6.20	3.92
Na_2O	2.52	2.98	2.10	2.30	2.58	2.97	9.28	10.52	10.85	12.19	7.74	8.85
K_2O	3.69	2.87	10.22	7.38	3.05	2.31	3.27	2.44	3.67	2.72	2.73	2.16
H_2O	3.68	14.97	2.76	0.34	3.78	14.97	1.01	3.95	0.69	2.65	1.33	5.25
CO_2	1.20	0.99	0.91	0.69	1.23	0.99	0.50	0.40	0.81	0.64	0.20	0.16
P_2O_5	0.63	0.32	0.40	0.20	0.65	0.33	0.85	0.42	1.24	0.61	0.66	0.33
$-F$	974.43		792.20		1,032.68		989.81		1,077.30		905.06	
$-F_{homo}$	974.43						989.81					
$-F_{immiscible}$				996.36						991.18		

$-F_{homo} = 80.3\,(100-3/2\mathrm{Al}-2\mathrm{Si})\sum_i (n_i.r_i)E_i$

$-F_{immiscible} = -(M_1F_1+M_2F_2)$ where M is the mol fraction of melt.

liquids. An initially gabbroic pluton may have differentiated to a considerable degree, and then separated an immiscible agpaitic fraction, which separated completely from its coexisting liquid, a process presumably requiring considerable periods at the appropriate temperature and pressure. This hypothetical process can readily be tested by experiment.

The tables of Nockolds[8] were searched to find other immiscible pairs of rock compositions, but without success. The average nephelinite and average nepheline syenite are close to being immiscible, as are the average gabbro and the average calc-alkaline syenite. The averaging process used to derive Nockold's values may obscure individual examples of possible immiscibility between these compositions. This question can be investigated by a variational procedure, in which the content of each ion is varied in turn and the effect on the free energy evaluated; such procedure would be aided by use of high speed computers. The search showed that there is a considerable range of generally gabbroic and generally syenitic compositions for which the formula predicts liquid immiscibility. All of these compositions are more or less peculiar by geological standards. Possible immiscible liquids must possess one or more of the following characteristics; unusually high potassium content (potassium is unique among major elements in having r/E greater than 1); low water content, because the small radius of H tends to inhibit immiscibility; low to moderate silica content, almost always less than 55%; and anomalous Si/Al ratios, especially in rocks rich in low valence cations.

The formula offers an easy test of the probability of liquid immiscibility between given chemical compositions. It correctly predicts the known examples of liquid immiscibility in silicate compositions, and in experimental systems seems to discriminate quite delicately between compositions showing immiscibility and those which do not. Only further experiments can show whether the formula is of general applicability, or whether the existing data happen fortuitously to fit a plausible, but incomplete, theoretical formulation.

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