

# A Partitioning Origin for Strontium Anomalies in Mantle-derived Melts

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On MORB- or mantle-normalised plots Sr is usually located between Ce and Nd as a reflection of the crudely similar partitioning behaviour of these cations during melting. Anomalous behaviour of  $Sr_N$  is referenced to  $Ce_N$  and  $Nd_N$  in terms of  $Sr^* = \sqrt{Ce_N \cdot Nd_N}$ . Sr anomalies identified in this way are conventionally interpreted in terms of source modification (enrichment or depletion in Sr) or fractionation of a Sr-rich phase, e.g. plagioclase or apatite. For example, positive (i.e.  $Sr/Sr^* > 1$ ) anomalies in olivine-hosted melt inclusions from Hawaii were recently interpreted as the result of subducted MORB material within the plume source region [1].

An alternative explanation for Sr anomalies is changes in partitioning behaviour of Sr and  $Sr^*$  in response to changing pressure (P), temperature (T) and composition. Although it has been recognised for decades that partition coefficients are not constant, most geochemists do not acknowledge the importance of such variability. The problem is especially acute when the partitioning behaviour of cations of different valence is being considered. Because  $Sr^{2+}$  and  $REE^{3+}$  have quite different substitution mechanisms and end-member compositions in mantle minerals, especially clinopyroxene, they will respond in quite different ways to P and T. Simply this is because the melting curves for fictive species  $REEMgAlSiO_6$  and  $SrMgSi_2O_6$  are not sub-parallel in P-T space. Lines of constant partition coefficient lie parallel to these melting curves. Consequently any polybaric melting trajectory will dissect  $D_{Sr}$ -P-T and  $D_{REE}$ -P-T space at different angles. The potential clearly exists to fractionate Sr from  $Sr^*$  simply as a function of P and T. Consideration of the extant partitioning data, as modelled by Wood & Blundy [2], shows that the  $REEMgAlSiO_6$  melting curve has a flatter P-T trajectory than the  $CaMgSi_2O_6$  (and by analogy the  $SrMgSi_2O_6$ ) melting curve. Thus melting at low P and high T will tend to produce higher  $D_{Sr}/D_{Sr^*}$  than melting at high P and low T.

In order to quantify these inferences we have conducted partitioning experiments on basanite and tholeiitic bulk compositions under near isothermal conditions over a wide pressure range [3]. Our results show conclusively that P-T changes can change produce large (i.e. ten-fold) anomalies in clinopyroxene-melt partitioning of Sr:

Run	P (GPa)	T (C)	% water	$D_{Sr}$	$D_{Sr^*}$	$D_{Sr}/D_{Sr^*}$
MA1	6	1200	20	0.126	0.051	2.52
1807	4	1160	15	0.159	0.125	1.27
1798	3	1100	1	0.136	0.102	1.33
1787	3	1200	10	0.108	0.095	1.14
1802	2	1080	5	0.066	0.224	0.29

A similar change in  $D_{Sr}/D_{Sr^*}$  can be seen by comparing the 3 GPa experiment of Hart & Dunn [4] with the 1.5GPa experiment of Blundy et al [5] on similar bulk compositions.

We conclude that under certain circumstances both positive and negative Sr anomalies in melts of clinopyroxene-bearing source rocks can be generated simply by changes in the P-T conditions of melting, without recourse to the presence of exotic or metasomatised source materials, or the fractionation of cryptic phases.

Sobolev AV, Hofmann AW & Nikogosian IK, *Nature*, **404**, 986-990, (2000).

Wood BJ & Blundy JD, *Contr. Min. Pet.*, **129**, 166-181, (1997).

Green TH, Blundy JD, Adam J & Yaxley GM, *Lithos*, **in press**, (2000).

Hart SR & Dunn T, *Contr. Min. Pet.*, **113**, 1-8, (1993).

Blundy JD, Robinson JAC & Wood BJ, *Earth Planet. Sci. Lett.*, **160**, 493-504, (1998).