Parental magmas for differentiated sills and large layered intrusions

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Using the COMAGMAT crystallization model (*Ariskin*, 1999) low pressure phase equilibria calculations have been conducted for a set of rocks representing the Marginal Series and Lower Zones from the differentiated sills (Vavucan, (Vav) Talnakh, (Tal) Kamenistyi (Kam)) and large layered complexes, such as Skaergaard (Ska), Kiglapait (Kig), and Dovyren (Dov). It allowed us to define the range of initial temperatures and parental magma compositions intrinsic to the original crystal mush from which the most primitive rocks have been crystallized (table). In parallel, estimates of primary crystal-melt proportions for the intrusive magmas were obtained. These modal proportions indicate that the original magmatic suspensions may contain from few percents (Siberian traps) to 15-25% (Talnakh and Kiglapait), and even 50-70% of crystals (Dovyren and Partridge River intrusion). This is in general agreement with results of dynamic calculations simulating emplacement of a non-isothermal magma which show the primary crystallinity of intrusive magmas is strongly depend upon the extent of cooling during the injection process (*Sharapov et al.*, 1997). Coupled with the results of the phase equilibria reconstruction these evidences argue that almost instantaneous injection of super-heated melts into magma chambers is unrealistic. This means that an early crystal sedimentation and (probably) compaction of the crystal piles should be considered as an important initial stage of the formation of layered intrusions, whether the further fractionation is caused mostly by crystal settling out of suspension during viscous flow or from a dispersed state during slow growth in an advancing zone of crystallization.

Body	**Vav**	**Tal**	**Kam**	**PRI**	**Ska**	**Dov**	**Kig**
h, m	100	100	200	500	2500	3200	9000
T, ºC	1195	1200	1170	1150	1165	1185	1230
SiO_2	49.54	48.75	49.71	46.81	50.01	55.00	47.17
TiO_2	1.19	1.30	1.39	1.15	1.68	0.74	1.08
Al_2O_3	15.57	15.42	14.76	18.79	12.95	15.52	17.70
FeO	11.18	12.00	14.75	12.31	13.24	7.58	13.51
MnO	0.28	0.22	0.26	0.14	0.19	0.14	0.19
MgO	7.91	7.94	6.64	8.85	6.90	7.33	8.03
CaO	11.72	11.43	10.13	8.80	12.40	10.80	8.73
Na_2O	2.12	2.16	1.74	2.57	2.37	1.72	3.19
K_2O	0.36	0.65	0.41	0.46	0.26	1.08	0.28
P_2O_5	0.13	0.14	0.21	0.12	0.15	0.08	0.12
Primary crystals, wt.%							
Ol	0.3	11.3	0.7	11.4	nd	46.5	4.8
Pl	1.8	2.7	41.3	56.6	nd	4.6	20.0

PRI – Partridge River intrusion.

References

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Sr isotope systematics in two glaciated crystalline catchments in the Swiss Alps

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The Sr isotope systematics are useful in the identification of the relative importance of different sources contributing to chemical weathering fluxes. We studied subglacial chemical weathering processes and the Sr isotope composition of runoff and particulate material in the two glaciated catchments of Oberaar (OA) and Rhone (RH) glacier (Swiss Alps). Both areas are contained within the crystalline rocks of the Aar Massif, and the lithologies are quite homogeneous and comparable, except for the presence of a zone of highly deformed variscide basement gneisses and schists in the Oberaar cachment.

We analysed meltwaters (RH $^{87}Sr/^{86}Sr$ = 0.7257 / OA 0.7155), suspended sediment (RH 0.7292 / OA 0.7134), precipitation (0.7104) and dust (0.7109), local bedrock (0.7101 – 0.7377), and subglacially precipitated calcite that is now exposed in front of the glaciers (RH 0.7182 / OA 0.7164).

RH meltwater ratio is smaller than RH suspended sediment (total digestions) which can be interpreted as a mixture of granodiorite (0.7101) and granite (0.7377). We explain this by the preferential weathering of calcite (disseminated or in veins), which has a relatively low $^{87}Sr/^{86}Sr$ ratio. An enrichment in Ca relative to Na in the meltwaters compared to suspended sediments is visible in both areas (OA > RH). In addition meltwaters could also be influenced by atmospheric input. The role of this will be assesed by mass balance calculations. The fact that OA meltwaters show an increased ratio compared to OA suspended sediment points to a minor atmospheric influence on our meltwaters: Increased OA meltwater ratios are better explained by the weathering of freshly ground biotite. The concentration of suspended sediment is higher for OA than for RH. OA suspended sediment contains more biotite due to the gneissic rocks within this catchment, what is also visible in the more elevated K flux.

The first order reaction in our catchments is weathering of calcite, but in addition, in the OA catchment biotite weathering exerts an other major influence on the meltwater $^{87}Sr/^{86}Sr$ ratio.