PROBLEM OF PRIMARY MELT GENESIS UNDER SPREADING ZONES OF THE WORLD OCEAN

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During decompression melting of the ocean mantle in spreading zones the igneous oceanic crust consisting from basalts (tholeiites of oceanic rifts (TOR), a dyke complex and underlaying gabbro is formed. Studies of a melting zone of under EPR area have shown, that a zone of the seismic low velocity reaching 3.95км/сек, is located directly under a ridge on depth about 30 km and proceeds on depth up to 150-200 km. The most part of melts centralize on rather shallow depth and only small one on depths up to 150 and deeper. The depth of generation (near 10 kbar) is typical for the most part World Ocean spreading zones, as for fast, and for slow ridges, so it has been estimated tholeiitic melts of "not complicated" provinces MOR have similar compositions [1]. The exceptions are the rather “colder” lithosphere provinces (for example, equatorial Atlantic, Knipovich Ridge), or the contrary, "hotter" one (northern Atlantic).

The last year studies basing as on direct melting experiments of natural and synthetic ultramafic rocks, and on theoretical models, have shown that there are enough difficulties for choosing model of initial melt generation under spreading zones. Now it is not possible completely to take into account all factors of melting proceeding so as partial melting continues often in open system when: 1 - the mantle can be heterogeneous, 2 - during of melting and upwelling to a surface the mantle changes its composition, 3 – during of melting the melts no full separate from mantle matrix, 4 - fluids or melts from other sources can migrate into zone of generation, for example, from areas of hot spots, 5 - mechanism and velocity of melt transportation may be differ from one province to another, and as during evolution. The estimation of influence of each of these factors has no unequivocal decision and consequently all developed models only in part approach us to the answer how and why a melting occurs under rift zones.

Upwelling mantle may be heterogeneous as a result of included recycling fragments of an ancient ocean crust, and also during its interaction with continental lithosphere at early stage of rifting formation. The forming enriched melts (for example, alkaline) may interact with matrix minerals at slow infiltration velocity, and can get on ridge valley along cracks, channels at their fast upwelling [2]. Enriched tholeiites may be extracted in spreading zones by models of incremental batch accumulative melting of primary mantle with constant presence from 0,1 up to 1 % melt resting in the mantle [3, 4 etc.].

Incoming to the top of mantle column melts can mix up either during transportation, or in top parts of a column, and form initial melts. Those melting parameters (P, T, c) will correspond to the average conditions of their formation. The most real interval of melt generation is 5-16 kbar, and the degree of melting changes from 8 up to 20 % [5]. There is a dependence of depth of melting, a melting degree and thickness of a growth crust. The lower production of magma generation corresponds to the least depth, the less growth crust thickness and the deeper rift valley. The temperature of magma generation under the most and the least deep rift parts differs on 250-300^{o}C. By experimental data [6] the most possible melting level is in Sp-Pl phase transition of lherzolite.

By studying the tholeiitic magmatism we have defined groups of glasses, which have been considered as parent melt derivative generating from lherzolite mantle in dry conditions from different depths. Melts enriched Si, Na and impoverished Fe (Na-TOR) extracted from the least of depth of mantle melting. TOR-2 melts generated near the point of Sp-Pl phase transition of primitive lhezolite (KLB-1) [7]. TOP-1 emphasizes most deep level of melting in comparison with other.

In spite of melts effusing on a ocean bottom represent total, integrated fraction, formed at different depths of mantle melting, the most magnesium melts can reflect parent ones, coming in intermediate chambers. The presence of phenocrysts of the most magnesium olivines (Fo89-91) in melts can be in equilibrium with lherzolite mantle.

We have carried out an estimation of parent melt compositions (types TOR-1, TOR-2, Na-TOR) by using return crystallization trend for the most magnesium glass average compositions of various provinces of the World Ocean. Melt compositions have been calculated up to the melts, equilibrated with lherzolite mantle. It was made by using calculated model COMAGMAT [8]. Determination of TOR-1 and TOR-2 mineral phases [1] has shown that they differ within the types. More high temperature and more magnesium liquidus olivines, reaching Fo91.5 are typical for TOP-1. Maximal magnesium of olivines for basalts such as TOR-2 is 90.4, for olivines Na-type – 89.5.

Table Initial melt compositions of different spreading zones of World Ocean

SiO_2	TiO_2	Al_2O_3	FeO*	MgO	CaO	Na_2O	K_2O	P_2O_5	Melt	Type	reference
49,32	0,60	15,10	7,65	13,08	12,38	1,61	0,06	0,01	TOR-1	TOR-1	[10]
49,74	0,86	17,80	7,05	9,52	12,47	2,32	0,06	0,05	TOR-2	TOR-2	[11]
48,98	0,97	17,94	7,38	10,06	12,21	2,19	0,06	0,08	TOR-2-BTП	TOR-2	[12]
49,78	1,03	17,05	7,30	9,77	12,47	2,32	0,06	0,09	TOR-2-TAG	TOR-2	[12]
48,71	0,77	17,79	6,10	10,09	12,04	2,30	0,03	0,04	TOR-2-Equat	TOR-2	[12]
50,86	0,99	17,09	6,92	9,93	10,99	2,91	0,31	-	Knz15-4	Na-TOR	[3]
49,27	0,91	17,19	7,56	11,09	11,49	2,27	0,22	-	Knz20-4	Na-TOP	[12]
51,31	0,99	17,57	6,41	9,42	10,48	3,30	0,31	0,20	Rmch-Na	Na-TOR	[12]
47,24	1,41	18,08	9,93	10,62	9,12	3,25	0,35	0,00	Btz20-6	Alk	[9]
48,32	1,30	17,75	9,00	9,60	9,86	3,40	0,60	0,18	Rmch-Mls	Alk.	[9]
48,00	1,57	16,29	7,61	10,62	11,62	2,96	0,92	0,41	Rmch-alk	Alk.	[12]
50,36	0,61	14,46	8,22	12,80	12,04	1,41	0,11	0,00	H-Si (Bt20-4-28 %)	TOR-Si	[9]

The average melt inclusions composition of northern Atlantic most magnesium olivines [7] was used as parent melt (TOR-1). Comparison of parent melts by different melting models of lherzolite with calculated parent melts by COMAGMAT program (see the table) has allowed estimating primary melt conditions (depth, temperatures and melting extents). The best approximation to our compositions had initial melts on [9]. Fig. 1 shows differences of types TOR-1, TOR-2 and Na-TOR first of all on Na contents.

As parent melt for Na-TOR were used melts from model [3], which has allowed to receive them with increased Na_2O contents (up to 3,5 %), SiO_2 and lowered FeO. By these model undepleted mantle melting began at 20 or 15 kbar and proceeded down to 4 kbar, and about 1 % of melt (fig. 1) constantly was present in a matrix.

Thus, mantle melting

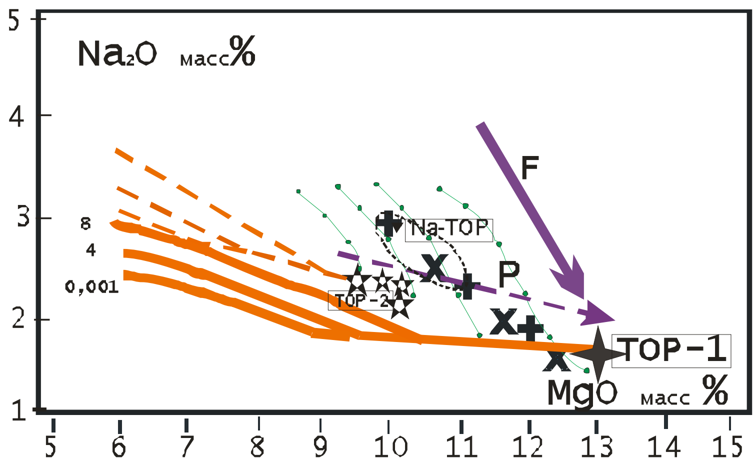

Fig.1. Comparison of estimated primary melt compositions of TOR-1, TOR-2 and Na-TOR types with primary melts by models [3, 9].
The changing of calculated MOR primary melts (black points) with pressure decreasing and melt degree increasing (of 4 %) are shown by black thin lines in intervals: **1.**18-17,4 kbars (summary degree F – 6%), 18-16 (10), 18-14 (14), 18-11,5(18), 18-8,5(22), 18-3,5(28); **2.**14-13,4(6),14-12(10),14-10,6 (14), 14-8,4 (18), 14-5,7(22); **3.**10-9 (6),10-8,(10),10-7(14),10-7(14),10-5, 4.(18);6-5,8 96), 6-5,4 (10), 6-3,5(16).
Also shown calculated line of fractionation for primary melts: TOR-1 (rhomb and thick lines); TOR-2 (star and dotted lines); Kinzler's model melts generated from depleted mantle (direct crosses) and from primary mantle (angle oblique crosses). It drawn as increasing magnesium as increasing melting intervals: 15-4 kbar (melting degree – 10 %), 20-4 (14 %), 25-4 (18 %). Arrows show changing of element concentrations with depth and melt degree increasing.

process in spreading zones is close to fractional polybaric when upwelling melt portions mix up among themselves. This mix will correspond to equation melt on the pressure adequate to average depth of a rising column. Estimated the basic level of TOR-1 generation is pressure of 20-10 kbar, average T = 1300^{o}C, F≥15 %, for TOR-2 P - 15-7 kbar, average T = 1270^{o}C, F > 10 %, and for Na-TOR – P - 15-4 kbar, T=1250^o C, F≈10 %. It is possible not full branch melt separation that results in lithophile element fluctuations in initial melts. Directly under spreading zone the central part of a column melts percolate upwards, but in apical parts they cannot reach a surface, resulting to formation metasomatism of the mantle**.**

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