Short Report

THE APPINITES AND ORE MINERALIZATION OF SOUTH SIBERIA

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The appinites are characterized of high concentrations of magnesium, strontium, barium, light REE, that its show mantle nature (Fowler, Henney et al., 2001). They has low contents of niobium, tantalium. The ratio of Sr/Nd of isotope data are showed its generation from mantle of EM source (Fowler, Henney, 1996; Muir et al., 1997).

The appinites founded on Altai-Sajan region South Siberia in much sites: Aiskiy, Terandjikskiy, Tarchatinskiy areals (Gornyi Altai), Zhernovskoi, Gornovskoy, Borsukskiy (Salair), Telbesskiy (Gornaj Shoriaj), Saksyrskiy, Hemchikskiy (Sajan), Askizskiy (Batenevskiy krjadg), Beloiussko-Tuimskiy (Kuzneckiy Alatau), Borok-Bibeevskiy (Tom-Kolyvanskaja zone). The appinites of its areals occurred in the edges of stocks (2 - 96 km^2) that has composite composition from monzogabbro to leicogranites.

The appinites in Gornyi Altai founded at edges of massifes of Aiskiy, Terandjikskiy, Tarchatinskiy complexes, that its time of moulding are in lower of Trias. This is time of generation different types of magmas and ores, connected with post collision setting, initiating by function with Siberian superplum. The stable paragenesis of dikes different composition from dolerites to granites with lamprophyres and massifs with appinites are watched in all areals. The lamprophyres are varies on different types of rocks (spessartites, vogesites, minetts, kersantites), but minetts occur in all areals from mafic to felsic types, that its relate to alkaline-basaltic of mantle magmas.

The appinites of Gornyi Altai are characterized by ours in detail (Gusev, Gusev, Tabakaeva, 2008). The intrusive massifs of Belokurikhinskiy complex (P_2-T_1) common occurrence in limits of Anuisko-Chuiskaja, Talitskaja, Biisko-Katunskaja, Balkhaschsko-Sadrinskaja, Teletsko-Chulischmanskaja, Holzuno-Chuiskaja structural-formation zones of Mountains Altai. The 5 phases derive in composite of complex in homodromic sequence: gabbro, diorites, syenites, grano-syenites, grano-diorites, granites, leico-granites, leico-granites with fluorite. The granitoids of Belokurihinskii complex carry for the first time to schoschonite type granite (SH). The petrologic peculiarities forming of intrusive massifs of complex discern and its fluid regime and role of fluid regime in generating of different types ore deposits.

The monzogabbro, monzodiorites, sienites are classified by appinites in different areals of Gornyi Altai, that has hybrid genesis and characterize high contents of MgO, Ni, Cr, Sr, Ba, light REE, and low concentrations of Nb, Ta (table 1).

The major and minor element variations are displayed in a series of rocks of Harker diagrams (Fig. 1). There are two main groups of elements. The first group incorporate elements which decrease steadly with increasing SiO_2, including TiO_2, Fe_2O_3, MnO, MgO, CaO. The second group incorporate elements that are concave downwards such as Al_2O_3 and Na_2O (Fig. 1).

The nomenclature of appinites are moderate alkaline, using plutonic TAS diagram of Middlemoust from monzogabbro to monzodiorite and monzonite. Some rocks fall within in fields of foid monzodiorite and foid monzosyenite (Fig. 2).

The compositions of appinites on diagram of Borodin's (Ac -A0) are forming trend in field of moderete alkaline series (Fig. 3).

The ratio of (La/Yb)N decrease from monzogabbro (10,7) to melanosyenite (2,9), that it show on poorly fractionated rare earth patterns. Positive anomalous of Eu detects in all rocks. The magnitude of Eu*N decrease from monzogabbro (32,1) to melanosyenite (24,7).

The low silica contents and high MgO, Cr, Ni associated with high transition metal abundences in the monzogabbro and monzodiorites are consistent miwth mantle derivation and high Cr/Ni suggests significant high-pressure fractionation involving olivine.

Two isotope systems were studied to provide further constraints on the extent of crustal interaction during magma evolution. The ratio $^{87}Sr/^{86}Sr$ varies from 0,7051 to 0,7076 and $^{143}Nd/^{144}Nd$ from 0,51186 to 0, 51202. The ratio εSr(t) – εNd(t) form line trend composites from monzogabbro to melanosyenites and are located near enriched mantle source type EM II (Fig. 4).

Table 1. Chemical analysis of appinites of Gornyi Altai

Components	1	2	3	4	5	6	7	8	9	10	11
SiO_2	48,71	50.13	50,93	55.27	56,21	57.12	49,77	54.77	59.10	48.35	55.37
TiO_2	1,42	1.24	1,19	1.18	1,35	1.44	1,07	1.12	1.32	1.08	1.22
Al_2O_3	16,76	13.03	13,51	13.56	10,23	16.17	12,35	12.56	13.17	13.12	12.53
Fe_2O_3	4,30	4.35	3,40	3.79	3,52	3.07	3,12	3.81	3.05	5.21	3.77
FeO	3,97	4.65	3,55	4.34	3,47	3.98	3,55	4.34	3.78	4.78	4.34
MnO	0,12	0.16	0,14	0.18	0,20	0.17	0,13	0.18	0.17	0.14	0.18
MgO	9,75	7.85	9,80	6.11	11,5	5.48	11,58	7.11	7.48	9.71	7.31
CaO	8,24	9.22	7,20	6.55	3,5	1.52	9,81	6.55	2.50	7.9	3.53
Na_2O	2,18	3.22	4,25	4.08	4,11	3.65	2,52	4.08	3.65	2.78	2.88
K_2O	4,11	3.67	4,12	3.76	3,8	7.23	4,03	3.88	5.23	3.45	6.78
П.п.п	2,39	1.45	0,90	1.67	1,1	0.32	2,01	0.61	0.22	2.51	0.81
P_2O_5	1,06	0.97	0,97	0.93	0,56	0.32	1,12	0.98	0.31	0.75	1.18
∑	100,0	99.94	99,96	99.75	99,55	99.47	99,94	99.99	99.98	99.78	99.90
Li	17,5	21.2	21,5	20.5	25,2	30.0	16,3	20.3	31.0	16.2	20.9
Rb	82	95	97	104	105	125	86	106	122	81	246
Cs	2,0	1.2	2,0	1.8	2,2	2.1	1,7	1.8	2.1	1.9	1.8
Be	6,0	6.3	7,4	7.5	5,0	2.5	4,5	7.7	2.7	5.5	7.7
Cr	523	397	386	147	138	125	412	156	129	478	153
Co	36	31	32	25	23	22	35	26	23	34	24
Ni	133	61	55	39	37	35	119	41	31	116	38
Sr	1876	1951	2370	2720	2930	2200	1965	2630	2120	1982	1610
Ba	2115	2072	2050	1970	2120	2500	2214	1920	2450	2145	997
La	32	14	17	16	33	17	35	16	19	28	16
Ce	55	42	43	44	54	46	58	46	49	51	46
Nd	26	21	21	22	25	22	31	23	22	24	23
Sm	8,5	6.8	6,7	6.6	6,5	6.5	9,7	6.6	6.7	8.3	6.6
Eu	2,6	1.71	1,7	1.67	1,72	1.64	2,8	1.69	1.66	2.7	1.69
Gd	8,4	6.9	6,8	6.6	6,5	6.5	8,5	6.7	6.8	8.3	6.7
Tb	1,3	1.2	1,0	1.1	1,0	1.1	1,4	1.1	1.1	1.4	1.1
Dy	6,1	5.5	5,2	5.3	5,2	5.1	5,5	5.4	5.4	6.4	5.4
Tm	0,8	0.7	0,7	0.6	0,5	0.5	0,9	0.6	0.5	0.9	0.6
Yb	2,1	3.6	3,8	3.4	3,0	3.1	2,2	3.7	3.3	2.2	3.7
Lu	0,8	0.7	0,7	0.6	0,6	0.5	0,9	0.6	0.5	0.9	0.6
Y	22	20.7	20,1	19.8	20,3	19.7	23	19.9	19.7	24	20.7
Sc	7,5	6.8	6,9	6.7	6,6	6.5	7,3	6.7	6.5	7.3	6.8
Th	3,1	4.3	4,4	4.5	4,8	5.8	3,2	4.7	5.9	2.9	4.7
Hf	2,6	4.6	4,3	4.8	3,6	4.9	2,5	4.8	4.9	2.4	4.5
Ta	0,3	0.4	0,4	0.5	0,6	0.5	0,5	0.5	0.5	0.3	0.4
Nb	7,4	6.2	6,3	6.2	4,2	6.3	6,4	6.3	6.5	5.2	6.6
Zr	155	342	327	338	327	334	125	335	314	1.64	295

Notes: samples were analyzed: for main components – chemical methods in Laboratory of IGaG SB RAS (Novosibirsk), for elements - method ICP-MS in Laboratory of IMGRE (Moscow). Aiskiy areal: 1-3 – monzogabbro, 4-5 – monzonites, 6- melanosyenite; Terandjikskiy areal: 7- monzogabbro, 8 – monzonite, 9- monzodiorite; dikes: 10 –shonkinite; Tarchatinskiy areal: 11- monzonite.

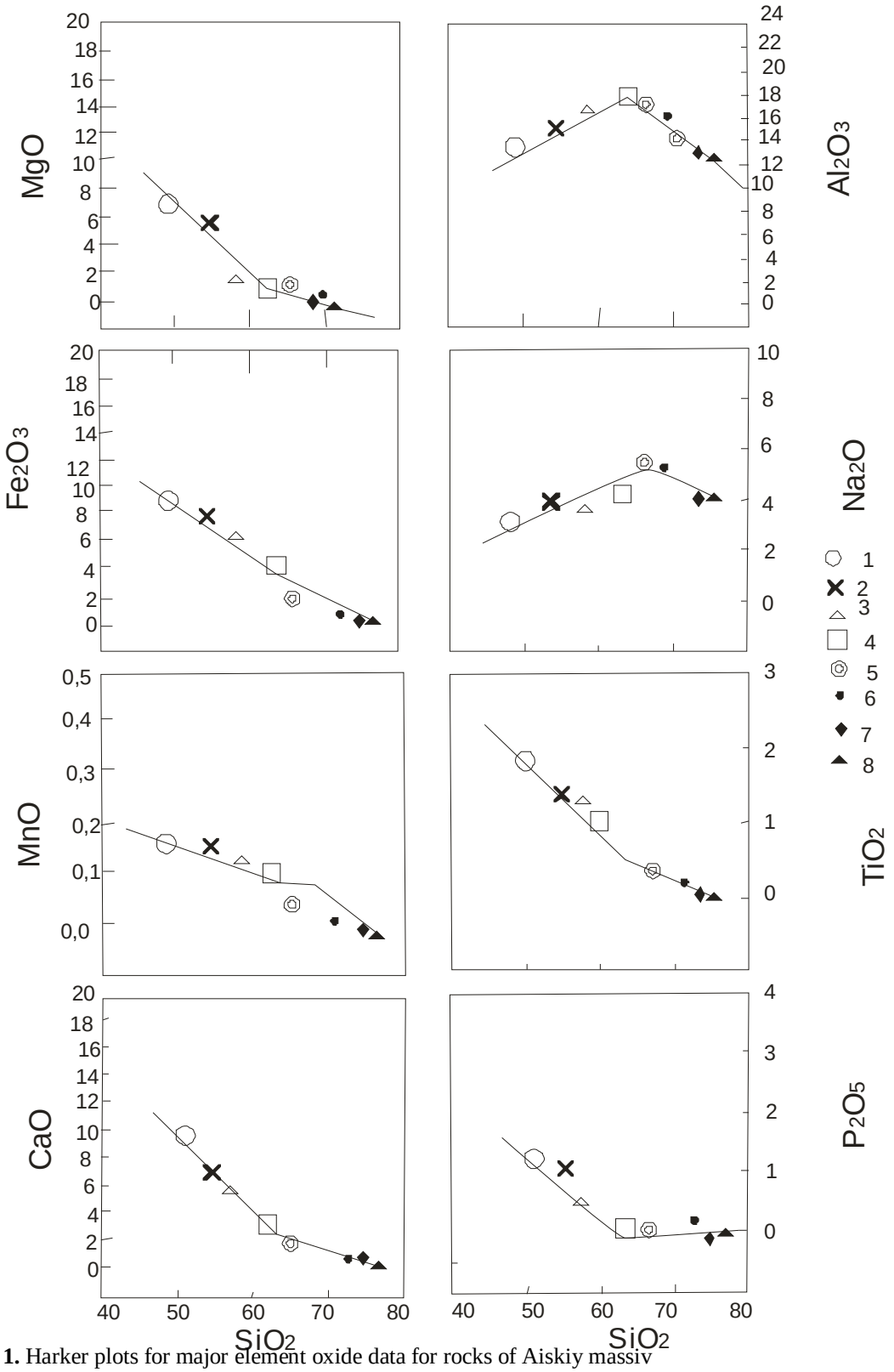

Figure 1. Harker plots for major element oxide data for rocks of Aiskiy massiv
1 - monzogabbro, 2- monzonite, 3- melanosyenite, 4- syenite, 5- granosyenite, 6- tonalite, 7- granite subalkaline, 8- leico-granite subalkaline with fluorite.

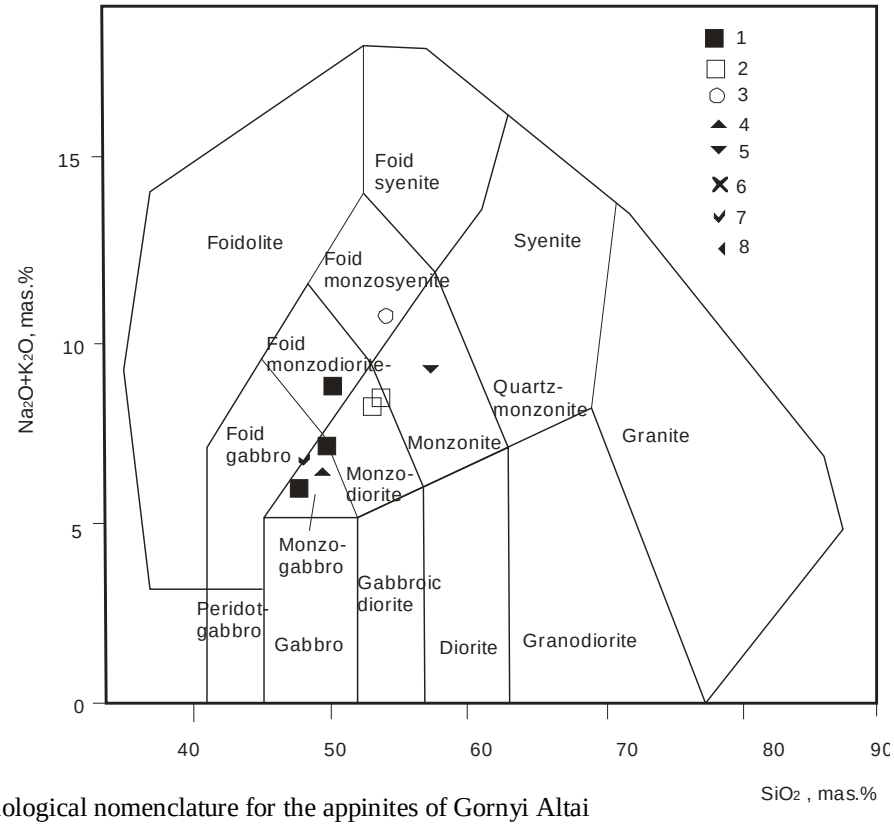

Figure 2. Lithological nomenclature for the appinites of Gornyi Altai
Aiskiy areal: 1- monzogabbro, 2- monzonites, 3- melanosyenite; Terandjikskiy areal: 4- monzogabbro, 5- monzonite, 6- monzodiorite; dikes: 7- shonkinite; Tarhatinskiy areal: 8- monzonite.

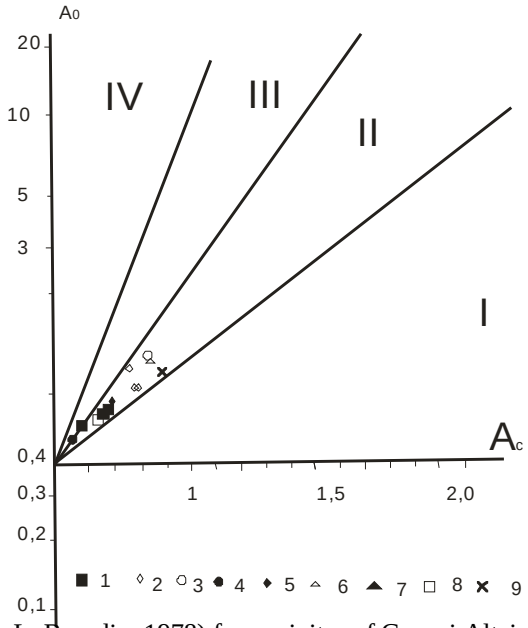

Figure 3. Diagram A_o - A_c (after L. Borodin, 1978) for appinites of Gornyi Altai
Field of series rocks: I - calc-alkali, II – moderate alkali, III – alkali, IV- high alkali. A_c - relative acidic (ratio of Si relative sum all major elements in atomic content); A_0 – relative alkali $(Na_2O+K_2O)/CaO$.
Aiskiy areal: 1- monzogabbro, 2- monzonites, 3- melanosyenite; Terandjikskiy areal: 4- monzogabbro, 5- monzonite, 6- monzodiorite; dikes: 7- shonkinite; Tarhatinskiy areal: 8- monzonite.

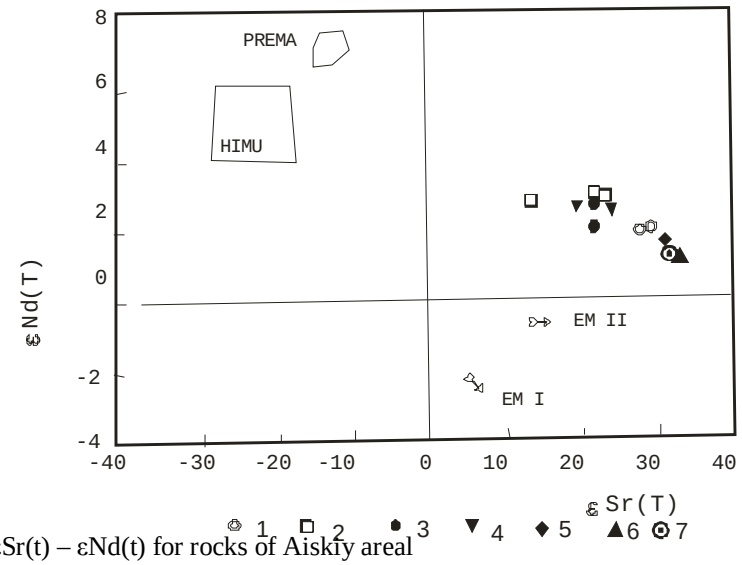

Figure 4. Diagram εSr(t) – εNd(t) for rocks of Aiskiy areal
The types mantle (after Zindler, Hart, 1986): EM I and EM II – enrich mantle types I and II; PREMA – primitive mantle; HIMU – mantle with high isotope U/Pb ratio.
Intrusive rocks of Aiskiy areal: 1- syenite, 2- granosyenite, 3- granite subalkaline, 4- leico-granite subalkaline with fluorite, 5- melanosyenite, 6- monzogabbro, 7- monzonite.

The different types deposits connected paragenetic and spatially with areal development appinites of South Siberia. SW-Mo skarns, W-Mo greisen and lode deposits, pegmatite beryllium, Ta-Nb, Li deposits, so lode gold-sulfide-quartz manifestations connect with intrusive massifs with appinites in Gornyi Altai. The intrusive massifs of complex occur so in Rudno-Altaiskaja structural-formation zone (Tigirekskii, Savvuschinskii) and in Salair (intrusives early extracting Zhernovskoi complex), where there are deposits rare-earth elements in pegmatites, lode manifestations and anomalies Sn, TR, Ta, Nb.

The large deposits of Fe- skarns, Cu-Mo- porphyries are link with intrusive of Telbesskiy complex in Gornaj Shoria.

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