

() ()

ghorbani@modares.ac.ir
(// : // :)

(LT)

(HT)

(HFSE)

: LT

.K, Ba, Sr

(LILE)

Ta, Nb, Ti

LT

LT

HT

Ta Nb

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(-b, c, d) (

" " Alavi () .(a)

Berberian *et al.*, (1982) .

Berberian and Berberian (1981)

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Zr, V, Y Ga, Sc, Ba, Ce ,Co

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Rb, Sr, Ba, Nb, Zr,

(LLD)

Hf ,Th

(LLD)

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XRF () Y, U, Mo

Phillips PW2400

NAA

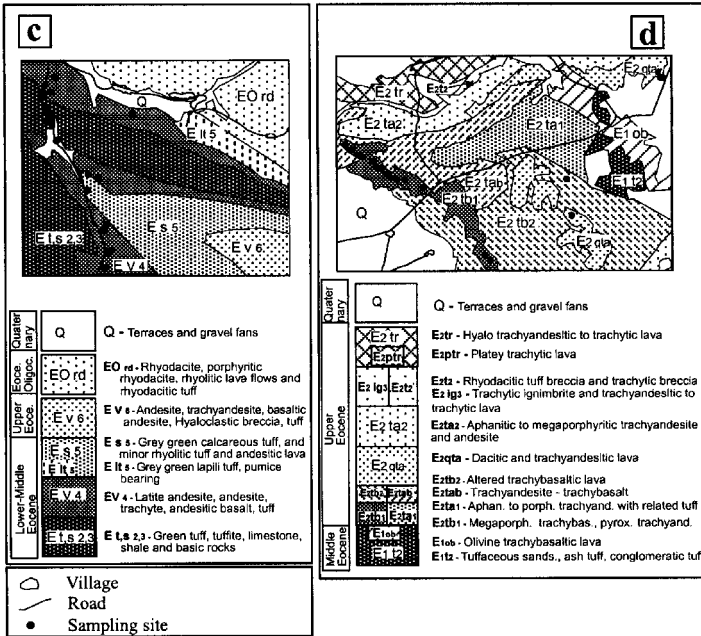
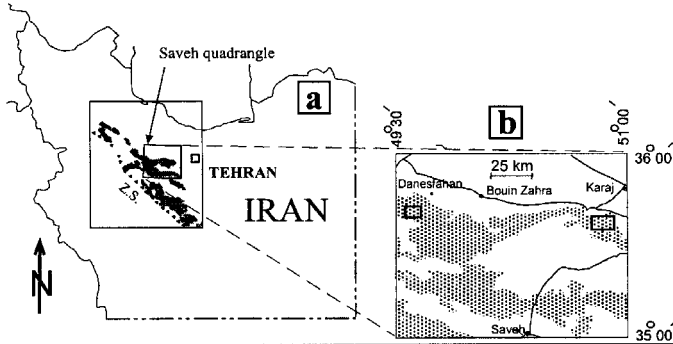
() La ,Ce, Nd ,Sm ,Yb

HIFAR

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() (a)

(Z.S.)

(b (Alavi, 1994)

(c)

() :

(d)

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(REE)

SW Danesfahan volcanic rocks								SW Karaj volcanic rocks			
	DS1	DS2	DS3	Ds4	Ds5	Ds6	DS7	KJ1	KJ2	KJ3	KJ4
SiO ₂	51.74	51.79	52.94	55.22	59.09	63.88	62.19	54.93	58.20	61.89	67.40
TiO ₂	0.58	0.72	0.72	0.76	0.70	0.67	0.53	1.14	1.05	1.01	0.65
Al ₂ O ₃	20.64	19.68	16.79	20.15	18.55	16.44	17.92	19.16	17.05	16.27	15.21
FeO _t	8.48	10.11	8.68	7.81	5.05	6.05	3.70	7.87	7.43	6.51	4.53
MnO	0.14	0.13	0.14	0.12	0.11	0.16	0.15	0.11	0.27	0.14	0.10
MgO	4.49	4.52	5.96	2.58	1.78	1.59	0.47	2.69	2.12	2.11	1.02
CaO	9.00	8.44	9.42	8.17	6.59	4.49	3.63	7.57	7.57	3.85	1.46
Na ₂ O	3.31	4.02	2.70	3.25	3.24	3.82	4.39	3.54	3.73	3.52	3.84
K ₂ O	0.85	0.40	2.29	1.69	4.48	2.62	6.76	2.54	2.17	4.26	5.57
P ₂ O ₅	0.71	0.14	0.27	0.18	0.34	0.23	0.20	0.40	0.33	0.37	0.16
S	0.05	0.06	0.08	0.06	0.07	0.04	0.06	0.06	0.08	0.07	0.05
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
L.O.I.	1.65	3.83	2.00	1.54	1.89	1.12	3.54	1.63	2.95	1.83	1.56
Mg#	0.39	0.35	0.49	0.32	0.36	0.30	0.20	0.34	0.30	0.35	0.31
Trace elements (XRF, ppm)											
Rb (1, 0.9)	24.7	7.4	52.2	34.6	150	62.9	186	75.1	50.5	141.5	176.5
Sr (0.9, 0.8)	288	713	525	465	455	380	307	508.8	442	319.5	178.6
Ba (8, 8)	298	292	575	446	730	827	872	437.2	526.5	759.1	1040
Nb (1, 0.2)	3.1	4.5	6.3	6.7	11.3	7.6	15.8	12	1.5	17.9	21.7
Zr (1, 0.3)	48.7	69.9	96.6	91	172	119	222	184.9	142.5	270.7	336.2
Y (1, 0.6)	13.9	17.8	19.2	19.2	21.5	31	27.2	31.4	30.4	42.8	46.6
U (2.9, 0.9)	-0.2	0.3	0.8	-1.1	2.6	2.7	4.4	1.6	-0.1	2.4	5.3
Mo (1.8, 0.5)	1	1.7	1.9	1.6	6.1	2.9	2.7	2.6	2.5	4.9	5.8
REE & Trace elements (NAA, ppm)											
La (0.05, 0.2)	5.61	7.54	16	15.6	24.3	19.4	38.4	26.1	25.2	37.1	43.7
Ce (0.5, 0.4)	12.2	17	30.5	29.5	45.6	39.1	68.8	51	49.3	73.8	84.9
Nd (1.0, 0.4)	6.59	9.64	14.8	15	21.1	19.3	30	24.2	24.7	36.1	39.4
Sm (0.01, 0.04)	1.72	2.4	3.36	3.45	4.21	4.63	5.86	5.71	5.59	7.5	8.16
Yb (0.03, 0.02)	1.32	1.75	1.69	1.83	2.2	3.04	2.78	2.89	2.74	4.19	5
Ta (0.5, 0.4)	-0.5	-0.5	-0.5	-0.5	0.82	0.54	0.93	0.84	0.65	1.11	1.47
Hf (0.2, 0.05)	1.3	1.66	2.65	2.53	4.66	3.52	6.02	5.12	4.06	7.83	9.79
Th (0.2, 0.07)	1.85	1.9	5.62	3.59	11.4	6.09	14.2	8.19	6.29	13.7	17.3

(LLD)

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TAS

() ()

Al

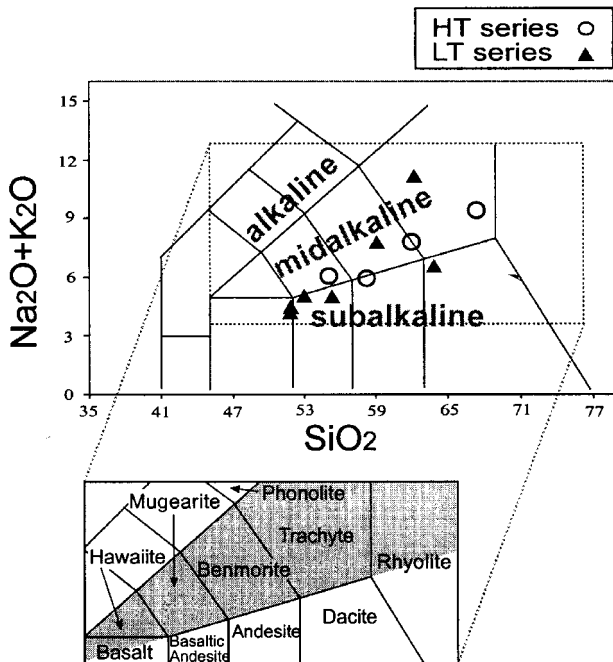
Ti

SiO₂-TiO₂

Ti

(LT)

(HT)



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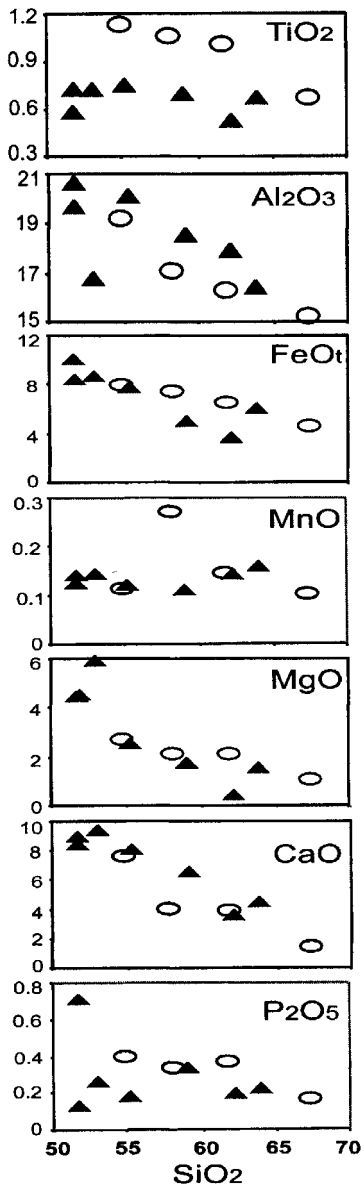
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Le Bas et al., 1986 TAS

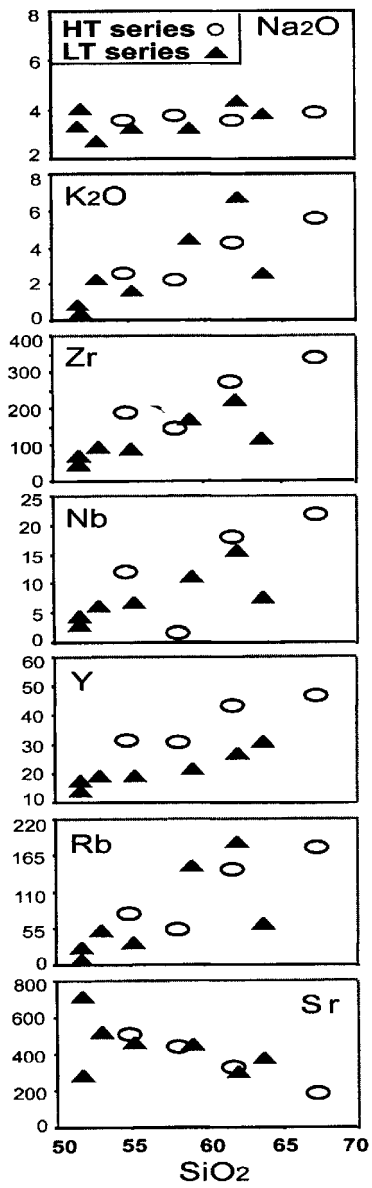
Middlemost (1997)

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() HT (



) LT

ppm

()

Mg

() /

Mg

Jaques and Green (1980)

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/

/

Mg

(Loss on Ignition) LOI

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()

()

LT

(-a)

Al₂O₃

.A.I

AFM

LT

(-b)

()

"

"

LT

HT

)

HT

(

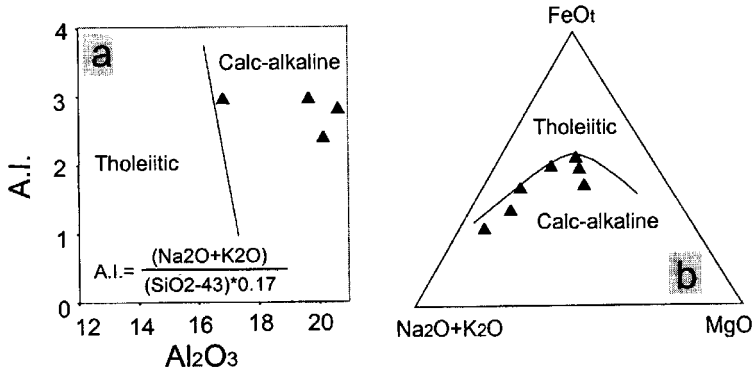
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Al, Fe, Mg Ca

+

+

+



(Middlemost, 1975) A.I.

Al_2O_3

LT

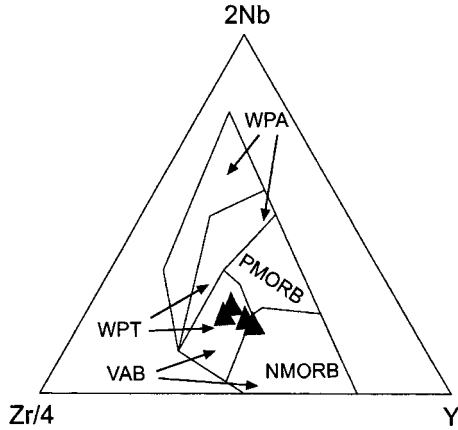
(a)

Irvine and AFM

LT

(b)

(Baragar, 1971)



(Meschede, 1986) "2Nb-Zr/4-Y"

LT

(VAB)

(PMORB)

(WPT)

(WPA)

(NMORB)

()

K HT LT (Sun and McDonough, 1989)

Nb Ba ,Sr

HT .(-a)

LT .

a , b d) HT

Th, U, Ta, Zr, Hf, Nb .(

HT (Jacob and Foley, 1999; Wilson, 1989)

LT HT

LT (Sun and McDonough, 1989)
.(-a)

HFSE LREE LILE Nb, Ta, Ti

.(Gill, 1981;Thompson *et al.*, 1984; White and Patchett, 1984 ;Saunders *et al.*, 1980)

NMORB
(rock/MORB) MORB .(BVSP, 1981; Pearce, 1982)

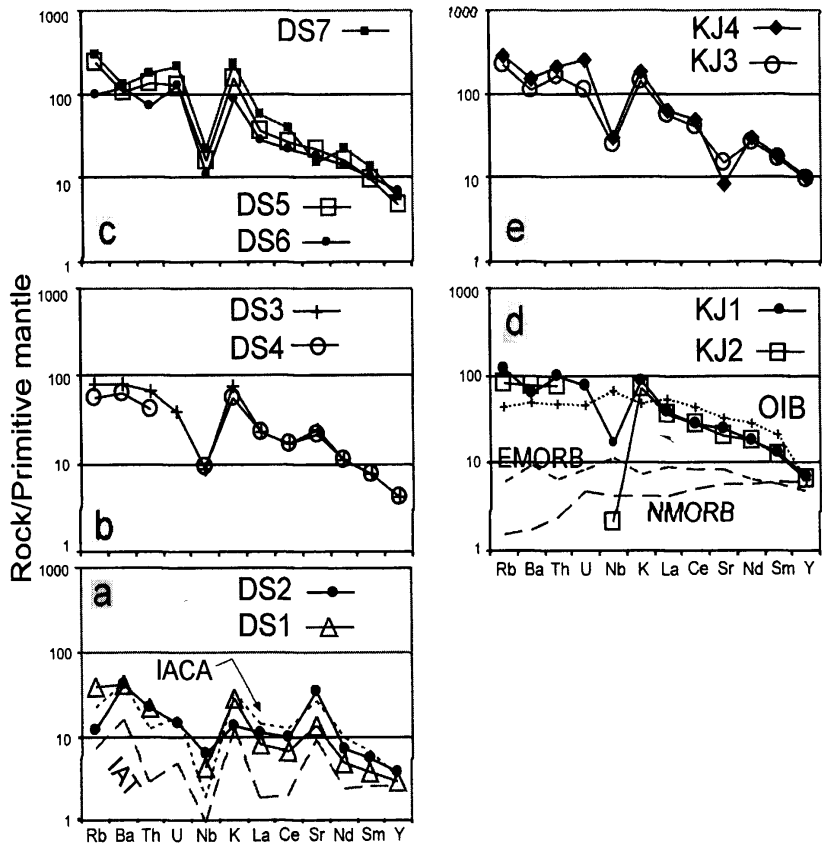
) MORB

(

Sr, Ba, K

S Danesfahan volcanics

S Karaj volcanics



(Sun and McDonough, 1989)

SiO₂ < 52 %wt

a

>58

c e

SiO₂ = 52-58 % wt

b d

(IACA)

SiO₂ %wt

(OIB)

Sun (1980) (IAT)

(EMORB)

(NMORB)

Sun and McDonough (1989)

()

Berberian *et al.*, (1982)

" "

/

-a

LT

Ba/Rb

Rb/Sr

(DS1)

(a) (DS2)

(Furman and Graham, 1999)

DS1

Th/U

(Reid and Ramos, 1996)

)

/ Gpa

Gpa :

(

(Tatsumi and Kogiso, 1997)

()

°C

Tronnes (2002)

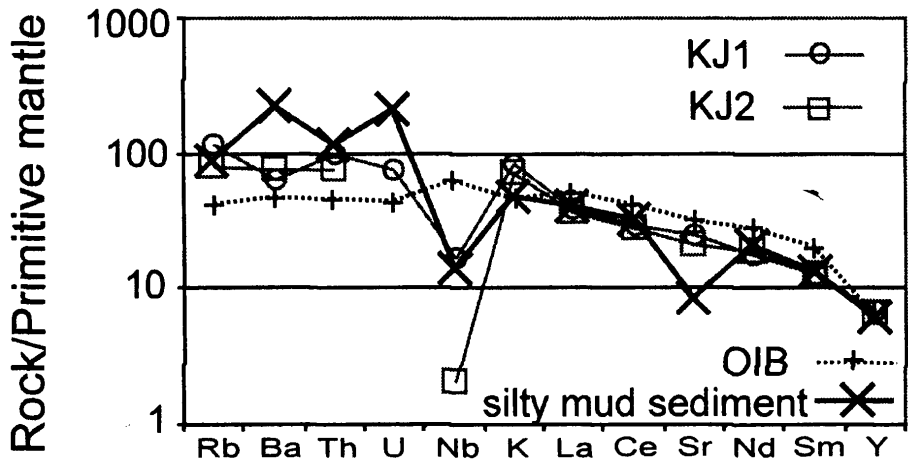
Gpa

(Wyllie, 1984 " ")

Finero

(Zanetti *et al.*, 1999)

(%) (%)



(Sun and McDonough, 1989)

(Plank and

OIB

HT

OIB

Langmuir, 1998)

HT

()

LT HT

HT

LILE

Carpathians

(Seghedi *et al.*, 2001)

Nb

LILE

LILE

Seghedi

()

LILE

LT

HT

LT

LILE

LREE

()

LREE

()

)

()

(

SiO₂-TiO₂

HT

(

b

KJ2

) HT

Nb

Mn

U

()

Mn

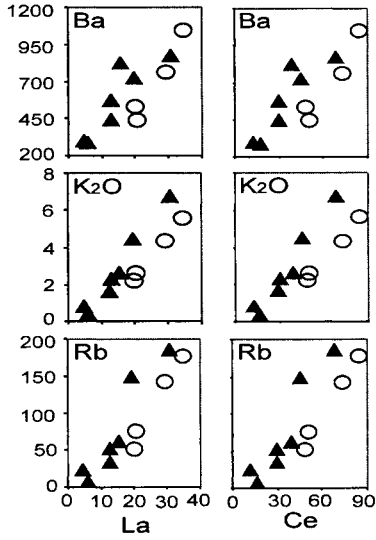
Nb

(Calvert, 1978; Hekinian *et al.*, 1982)

KJ2

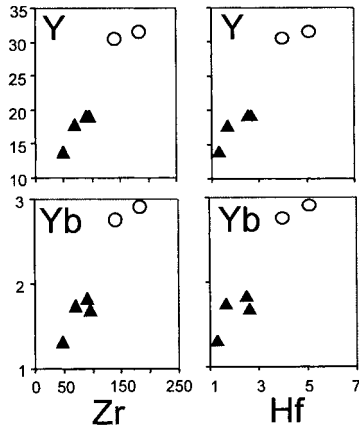
U

(Gerth, 1990)



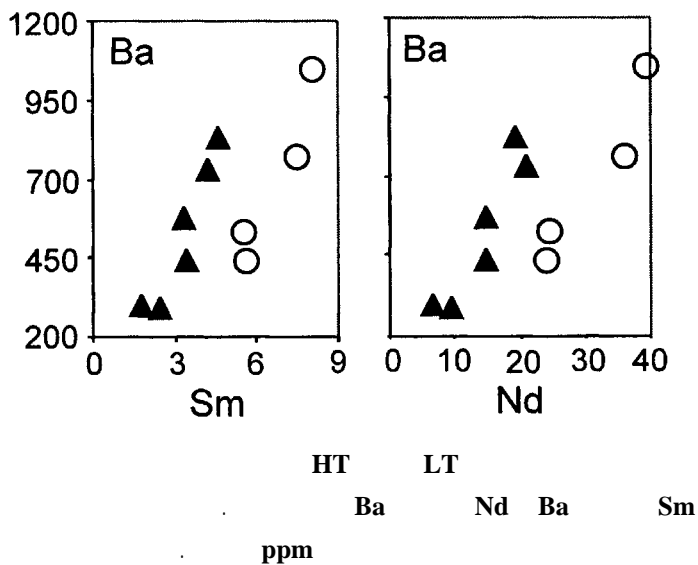
) Ba Rb ,K₂O (LREE) Ce La
 () HT () LT (LILE

ppm



. Yb Y (HFSE) Zr Hf
 () LT () HT
 ppm

()



()

()

(Briggs and McDonough, 1990; Wendt *et al.*, 1997; Kita *et al.*, 2001)

LT

(HT)

(OIB)

LT

Mantle Plume

HT

References

- Alavi, M. (1996) *Tectonostratigraphic synthesis and structural style of the Alborz Mountain system in northern Iran*. J. Geodynamics, **21**, 1, 1-33.
- Alavi, M. (1994) *Tectonics of the Zagros orogenic belt of Iran: new data and interpretations*. Tectonophysics, **229**, 211-238.
- Berberian, F., Berberian, M. (1981) *Tectono-plutonic episodes in Iran*. In: Delany, F.M. and Gupta, H.K. (Eds.) Am. Geophys. Union, Geodynamics Series, pp. 5-32.
- Berberian, F., Muir, I.D., Pankhurst, R.J., Berberian, M. (1982) *Late Cretaceous and Early Miocene Andean type plutonic activity in northern Makran and Central Iran*. J. Geol. Soc. Lond., **139**, 605-614.
- Briggs, R.M., McDonough, W.F. (1990) *Contemporaneous convergent margin and intraplate magmatism, North Island, New Zealand*. J. Petrol., **31**, 4, 813-851.
- Basaltic Volcanism Study Project (1981) *Basaltic volcanism on the terrestrial planets*. Pergamon Press, Inc., New York. 1286 pp.
- Calvert, S.E. (1978) *Geochemistry of oceanic ferromanganese deposits*. In: Paton, A., Kent, P., Deacon, G., Hutchinson, K., Ranken, M.B.F. (organizers) *Sea floor development; moving into deep water*. Phil. Trans. Royal Soc. Lond., Series A, **290**, 43-73.
- Furman, T., Graham, D. (1999) *Erosion of lithospheric mantle beneath the east African rift system: geochemical evidence from the Kivu volcanic province*. Lithos, **48**, 237-262.
- Gerth, I. (1990) *Unit-cell dimensions of pure and trace metal associated goethites*. Geochim. Cosmochim. Acta, **54**, 363-371.
- Gill, J.B. (1981) *Orogenic andesites and plate tectonics*. Heidelberg: Springer Verlag, 390 pp.
- Gordon, G.E., Randle, K., Goles, G.G., Corliss, J.B., Beson, M.H., Oxley, S.S. (1968) *Instrumental activation analysis of standard rocks with high resolution gamma-ray detectors*. Geochim. Cosmochim. Acta, **32**, 369-396.
- Hekinian, R., Renard, V., Cheminee, J.L. (1982) *Hydrothermal deposits on the East Pacific Rise near 13N: geological setting and distribution of active sulfide chimneys*. In: Rona, P.A., Bostrom, K., Laubier, L., Smith, K.L., (eds), *Hydrothermal Processes at Seafloor Spreading Centers*. New York: Plenum, pp. 571-594.

- Irvine, T.N., and Baragar, W.R.A. (1971) *A guide to the chemical classification of common rocks*. *Canad. J. Earth Sci.*, **8**, 523-548.
- Jacob, D.E., Foley, S.F. (1999) *Evidence for Archean oceanic crust with low high field strength element signature from diamondiferous eclogite xenoliths*. *Lithos*, **48**, 317-336.
- Jaques, A.L., Green, D.H. (1980) *Anhydrous melting of peridotite at 0-15 kb pressure and the genesis of tholeiitic basalts*. *Contrib. Mineral. Petrol.*, **73**, 287-310.
- Kita, I., Yamamoto, M., Asakawa, Y., Nakagawa, M., Taguchi, S., Hasegawa, H. (2001) *Contemporaneous ascent of within-plate type and island-arc type magma in the Beppu-Shimabara graben system, Kyushu island, Japan*. *J. Volcanol. Geotherm. Res.*, **111**, 99-109.
- Le Bas, M.J., Le Maitre, R.W., Streckeisen, A., Zanettin, B. (1986) *A chemical classification of volcanic rocks based on the total alkali-silica (TAS) diagram*. *J. Petrol.*, **27**, 745-750.
- Meschede, M. (1986) *A method of discriminating between different types of mid-ocean ridge basalts and continental tholeiites with the Nb-Zr-Y diagram*. *Chem. Geol.*, **56**, 207-218.
- Middlemost, E.A.K. (1975) *The basalt clan*. *Earth Sci. Rev.*, **11**, 337-364.
- Middlemost, E.A.K. (1997) *Magma, rocks and planetary developments, a survey of magma/igneous rock system*. Addison Wesley Longman Limited, 299 p.
- Norrish, K., Hutton, J.T. (1969) *An accurate X-ray spectrographic method for the analysis of a wide range of geological samples*. *Geochim. Cosmochim. Acta*, **33**, 431-453.
- Plank, T., Langmuir, C.H. (1998) *The chemical composition of subducting sediment and its consequences for the crust and mantle*. *Chem. Geol.*, **145**, 325-394.
- Reid, M.R., Ramos, F.C. (1996) *Chemical dynamics of enriched mantle in the southwestern United States: Thorium isotope evidence*. *Earth Planet. Sci. Lett.*, **138**, 67-81.
- Saunders, A.D., Tarney, J., Weaver S.D. (1980) *Transverse geochemical variations across the Antarctic Peninsula: implications for the genesis of calc-alkaline magmas*. *Earth Planet. Sci. Lett.*, **46**, 344-360.
- Seghedi, I., Downes, H., Pecskey, Z., Thirlwall, M.F., Szakacs, A., Prychodko, M., Matthey, D. (2001) *Magma genesis in a subduction-related post-collisional volcanic arc segment: the Ukrainian Carpathians*. *Lithos*, **57**, 237-262.
- Sun, S.S. (1980) *Lead isotopic study of young volcanic rocks from mid-ocean ridges, ocean islands and, island arcs*. *Phil. Trans. Royal Soc. Lond., Series A*, **297**, 409-445.
- Sun, S.S., McDonough, W.F. (1989) *Chemical and isotopic systematics of oceanic basalts: implications for mantle composition and processes*. In: Saunders, A.D. and Norry, M.J. (eds) *Magmatism in the ocean basins*, *Geol. Soc., Lond., Spec. Publ.*, **42**, 313-345.
- Tatsumi, Y., Kogiso, T. (1997) *Trace element transport during dehydration processes in the subducted oceanic crust: 2. Origin of chemical and physical characteristics in arc magmatism*. *Earth Planet. Sci. Lett.*, **148**, 207-221.

Thompson, R.N., Morrison, M.A., Hendry, G.I., Parry, S.J. (1984) *An assessment of the relative roles of crust and mantle in magma genesis: an elemental approach*. Phil. Trans. Royal Soc. Lond., **A310**, 549-590.

Tronnes, R.G. (2002) *Stability range and decomposition of potassic richterite and phlogopite end members at 5-15 Gpa*. Mineral. Petrol., **74**, 129-148.

Wendt, J.I., Regelous, M., Collerson, K.D., Ewart, A. (1997) *Evidence for a contribution from two mantle plumes to island-arc lavas from northern Tonga*. Geology, **25(7)**, 611-614.

White, W.M., Patchett, J. (1984) *Hf-Nd-Sr isotopes and incompatible element abundances in island arcs: implications for magma origins and crust-mantle evolution*. Earth Planet. Sci. Lett., **67**, 167-185.

Wilson, M. (1989) *Igneous petrogenesis; a global tectonic approach*. Chapman & Hall, 466 p.

Wyllie, P.J. (1984) *Constraints imposed by experimental petrology on possible and impossible magma sources and products*. Phil. Trans. Royal Soc. Lond., **A310**, 439-56.

Zanetti, A., Mazzucchelli, M., Rivalenti, G., Vannucci, R. (1999) *The Finero phlogopite-peridotite massif: an example of subduction related metasomatism*. Contrib. Mineral. Petrol., **134**, 107-122.

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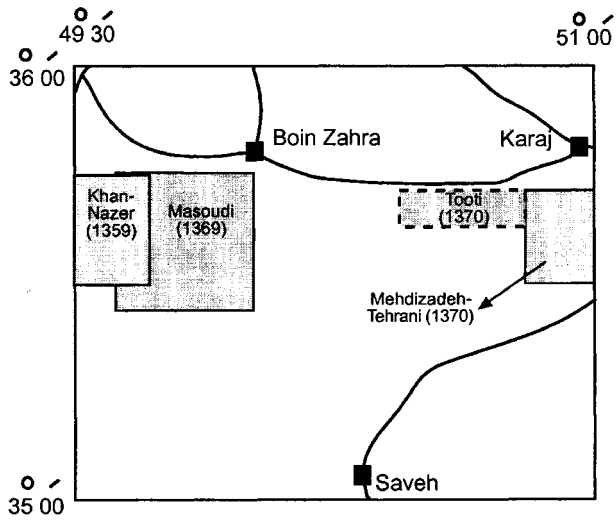
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(b)

