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XRD, XRF, ICPMS

The Study of Geology, Geochemistry, Mineralogy and Evaluation of the Industrial Applications of Torab Clay Deposit ,in South Abarkouh, a None Reported Case of Global Clay Genesis Evidence in Permo-Teriass

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Abstract

The Torab clay deposit is located in the Bikheirkhong plain in 70km south of Abarkouh. This plain is located in the north of the Sanandaj-Sirjan metamorphic zone and it is a part of clay-rich province of the south Abarkouh. This plain is in continuation of the well known Shahreza-Abade-Hambast's clay belt. The stratigraphical age of the clay layers is attributed to Permian (Artinskian). This age is within the time of the global evidence of clay genesis in Permo-Triassic time. In this study, the Torab clay deposit is chosen as a typical example of the region clay deposits. For mineralogical and geochemical studies, we used XRD, XRF, ICPMS and soil mechanical methods. The sediments of the Torab clay deposits are a kind of highly weathered Paleosols. These sediments have diverse resources which can be the sedimentary reworked cycles or they can be the erosion products of some felsic and mafic rocks. The results of studies on stratigraphy, mineralogy, geochemical properties, sedimentary basin condition and geological and geographic position show a correlation between these clay sediments and the global evidence of clay genesis in Permo-Triassic period. Autogenic transformations had a great effect on improvement of soils industrial properties. This soil has proper range of harmful and useful industrial elements and suitable mineralogical and mechanical properties to be used in pottery and brick making. This soil is also suitable for pharmacological uses.

Keywords: Clay, Permo-Triassic, Geochemistry, Mineralogy, South Abarkouh.

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(Sheng et al., 1984; Yin et al., 1985, 1996)

(Yin et al., 2001)

) (Murray, 2007)
(- -

(1972) Taraz
(a)
(b) (PTB) -
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Taraz .

(1972)

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(Taraz, 1972)

(Late Artinskian)

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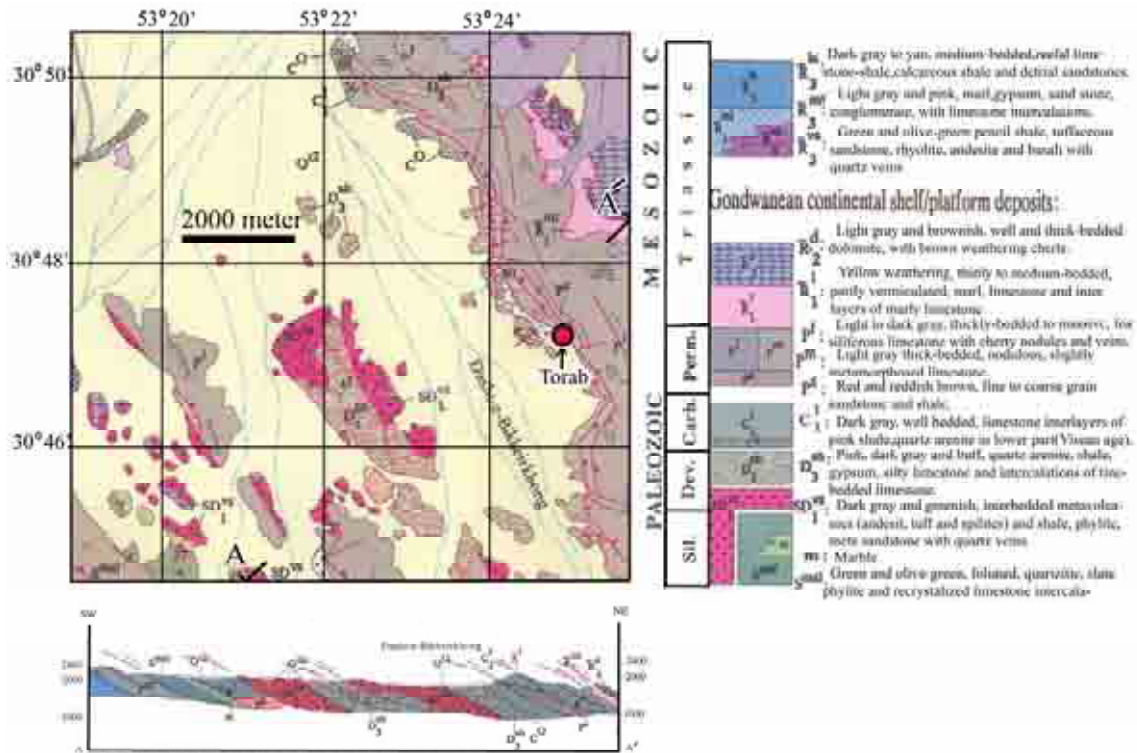
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(Taraz, 1972)

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(TR-1,TR-2,TR-3)

(TB-1,TB-2)

(UR)

(LB)

TB-2

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XRF () XRD

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ICPMS



Perkin-Elmer ELENA6000

Phillips powder X_ray

diffractometer(PW 3710)

45kV/35Ma

CuK α

XRD

JCODS

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(JCPDS,1995)

:

(Fabberi et al., 1995)

Phillips

:

30kV/60mA

Rh

PW 1400 XRF

USEPA-3052

ICPMS

XRD

	Illite%	Kaolinite%	Quartz%	Albite%	Gypsum%	Natroalunite%	Goethite%	Paragonite%
TR-1	30	17	35	3	4	4	3	2
TR-2	31	19	39	3	3	2	2	0
TR-3	32	20	40	2	1	0	2	2
BT-1	18	56	19	2	2	1	1	0
BT-2	22	50	21	2	0	0	0	0

sample	Liquid limite (LL)	Plastic limit (PL)	Plasticity index (PI)
TR1	47.2	26.7	20.5
TR2	45.5	26.2	19.3
TR3	47.8	28.7	19.1
TB1	45.3	27.2	18.3
TB2	44.1	29.1	16

. (Zhang, 1993; Yin, 1996)

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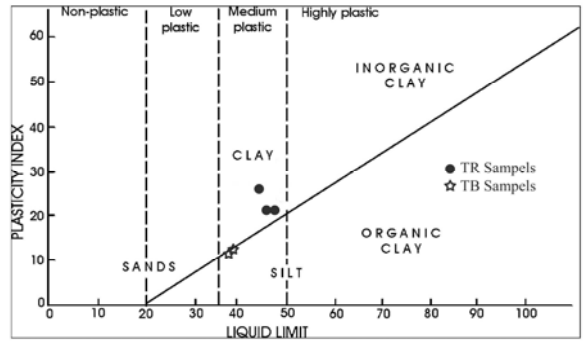
Highley, 1978)

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(Nettleton et al., 2000)

(paleosol)



(Zhang, 1993; Dudek and Srodon,

.2003; Bergaya, 2006)

(Bain and

Highley, 1978)

(Transform)

Booklet

(Murray, 2007)

(Flinte clay)

(Ball Clay)

(Bergaya, 2006; Murray, 2007)

(Common Clay)

(Fire Clay)

(Grim, 1962)

(Bergaya, 2006)

(Refractory Clay)

(China Clay)

(Bergaya, 2006; Murray, 2007)

(Cullers &

$$CIA = [Al_2O_3 / (Al_2O_3 + CaO + Na_2O + K_2O)]$$

XRF

$$CIW = [Al_2O_3 / (Al_2O_3 + CaO + Na_2O)]$$

	SiO ₂ %	Al ₂ O ₃ %	TiO ₂ %	Fe ₂ O ₃ %	MnO %	MgO %	CaO %	Na ₂ O %	K ₂ O %	P ₂ O ₅ %	SO ₃ %	L.O.I %	Cl ppm	Ba ppm	Ce ppm	Co ppm	Th ppm	U ppm	Cr ppm
TR-1	53.03	23.83	1.02	4.46	0.006	0.21	1.27	1.02	2.53	0.07	3.5	7.5	1620	371	115	8	15	3	106
TR-2	55.71	23.6	1.25	4.21	0.012	0.41	1.1	1.11	2.92	0.091	1.5	6.4	2200	385	130	33	9	2	126
TR-3	53.2	24.7	1.19	2.13	0.02	0.3	0.78	1.02	3.01	0.07	0.33	11.71	472	215	145	11	16	3	86
TB-1	57.66	25.5	2.5	0.54	0.12	0.11	1.42	0.49	1.07	0.11	0.7	8.3	459	336	104	17	17	4	93
TB-2	57.7	25.1	1.32	1.12	0.91	0.18	1.24	0.31	0.93	0.99	0.02	8.09	403	345	116	20	14	3	90
NASC	64.8	16.9	0.7	5.65	0.06	2.86	3.63	1.14	3.97	0.13	----	----	----	636	----	25.7	12.3	2.6	125
UC	66	15.2	0.5	5	0.08	2.2	4.2	3.9	3.4	----	----	----	----	550	----	10	10.7	2.8	35
	Mo Ppm	Cu ppm	Nb ppm	Ni ppm	Pb ppm	Rb ppm	Sr ppm	V ppm	W ppm	Y ppm	Zr ppm	Zn ppm	CIW	CIA	K/Rb	Th/U	K ₂ O/ Na ₂ O	TiO ₂ /Zr *100	SiO ₂ / Al ₂ O ₃
TR-1	1	10	23	43	39	116	218	132	6	30	161	43	86.5	79.3	93	5	1.01	0.63	2.22
TR-2	1	105	19	39	17	75	166	156	18	21	143	57	88	79.3	130	4.5	1.38	0.87	2.36
TR-3	1	12	27	19	28	91	103	113	29	30	197	70	91.4	82.3	87	5.3	1.98	0.60	2.15
TB-1	1	5	23	22	23	62	320	125	15	26	188	41	89.1	85.9	96	4.25	0.64	0.13	2.26
TB-2	1	52	21	27	25	80	207	130	17	23	195	60	89.1	86.2	112	4.6	0.51	0.67	2.29
NASC	----	----	13	58	----	124	142	130	----	35	200	----	77.9	65.9	----	4.7	3.48	0.35	3.83
UC	----	25	25	20	----	112	350	60	----	22	190	71	65.2	56.9	----	3.8	0.87	0.26	4.34

(Graf, 1983)

XRF

(Wilson, 2004)

(Geromet NASC

(Taylor UC

et al., 1984)

et al., 1985)

MnO

(Dondi et al., 2001)

(Maynard, 1983)

PH

Mn

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(Nyakairu et al., 2001)

(Goldbery, 1987)

Eh

(Health, 1974)

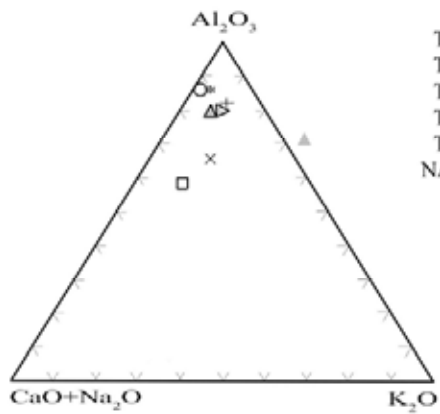
(Zhang, 1993)

TR-3

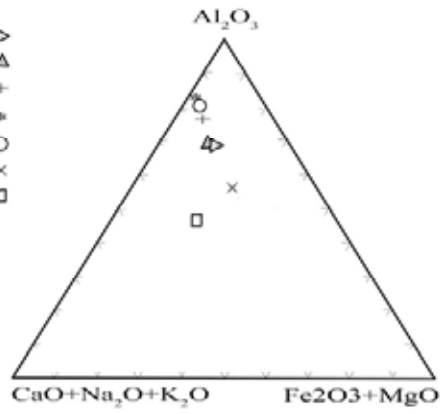
L.O.I

(Maynard, 1983)

Eh



- TR-1 ▷
- TR-2 ▲
- TR-3 +
- TB-1 *
- TB-2 ○
- NASC ×
- UC ◻



(1996) Nesbitt et al

UC

(1984) Geromet et al.

NASC

(1985) Taylor et al.

(Nesbitt

Na, Ca, Sr

et al,1996)

(Nesbitt & Young, 1982) CIA

NASC

(Harnoise,1988) CIW

(Wronkeiewicz & Condile,1987) UC

) CaO

CIW CIA

(/

CIA

(Nesbitt et al., 1996)

CIA

(Tailor & McLennan.,1993)

(Wronkiewicz, Condie, 1987)

K_2O/Na_2O

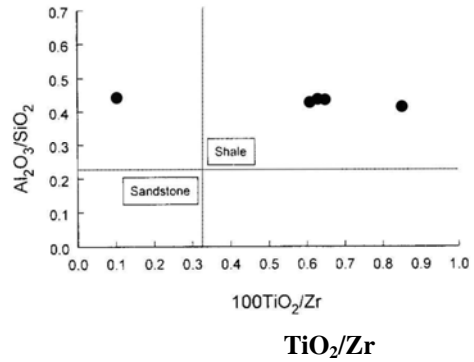
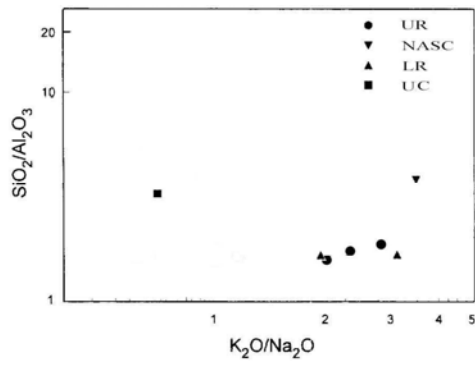
CIW CIA

TiO_2/Zr

(Zhang et al.,1993)

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(Nesbitt et al.,1980)

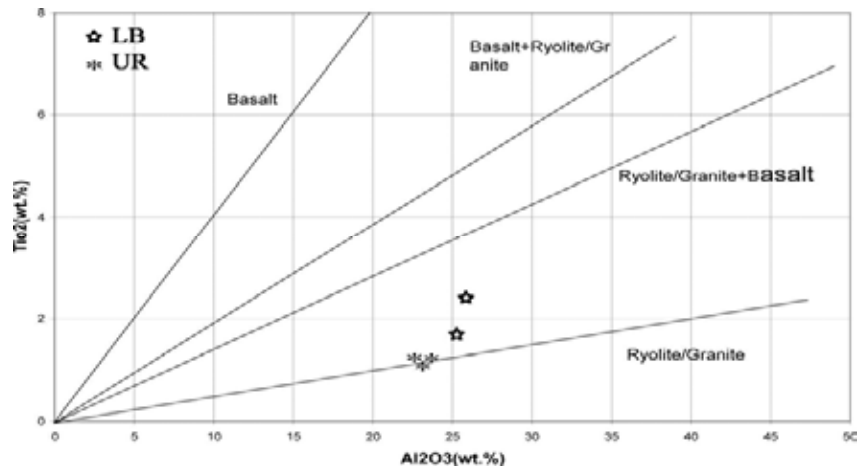


NASC

Garcia et

UC

(1994) al.



(2001) Ekosse

(Garcia et al., ()

K2O/Na2O .1994)

NASC

NASC

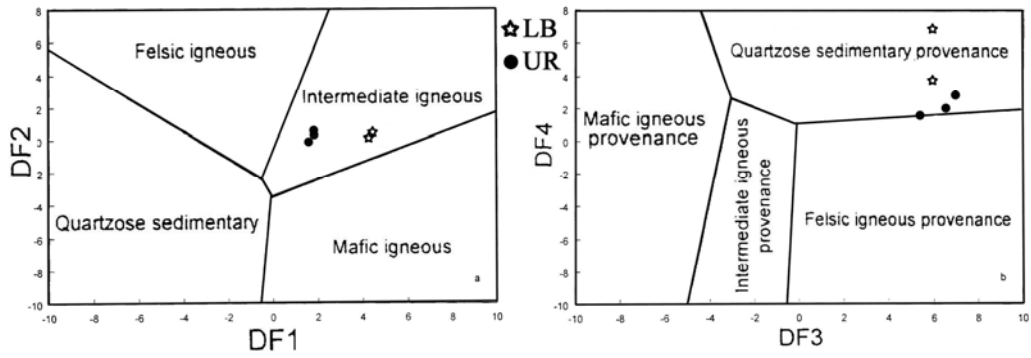
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(Roser & Korsch, 1988)

() Al₂O₃ TiO₂

.()

(Eekosse,2001)



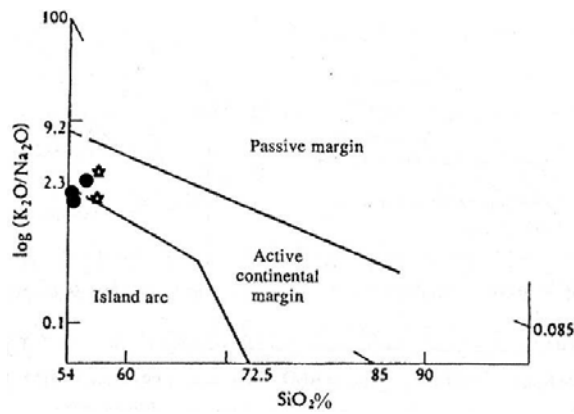
(Roser & Korsch, 1988)

$$DF1 = -1.773TiO_2 + 0.607Al_2O_3 + 0.76Fe_2O_3 - 1.5MgO + 0.616CaO + .509Na_2O - 1.224K_2O - 9.09$$

$$DF2 = 0.445TiO_2 + 0.07Al_2O_3 - 0.25Fe_2O_3 - 1.142MgO + 0.438CaO + 1.475Na_2O + 1.426K_2O - 6.861$$

$$DF3 = [30.638TiO_2 - 12.541Fe_2O_3 + 7.32MgO + 12.031Na_2O + 35.402K_2O] / Al_2O_3 - 6.382$$

$$DF4 = [56.5TiO_2 - 10.879Fe_2O_3 + 30.875MgO - 5.404Na_2O + 11.112K_2O] / Al_2O_3 - 3.89$$



(Roser & korsch, 1986)

() (1986) Roser & korsch

Stampfli & Borel

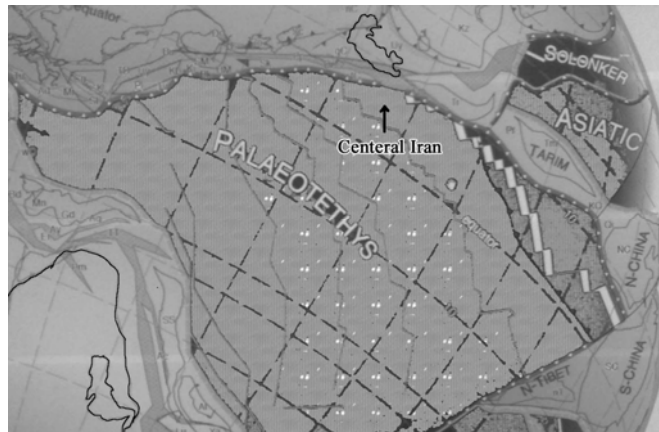
(1965) (1988) Zawada

()

(2002)

Campbell & Williams

K/Rb



(Stampfli & Borel 2004) ()

Ba Sr

(Stampfli & Borel 2004) ()

U Zr , Nb , Y , Th

(Bergaya, 2007)

(Dill et al., 1997)

Fe+Ti/Cr+Nb

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Fe Ti Cr Nb

(Feng & Kerrich,

Th/U . 1990)

Cr Nb

()

ppm

ppm

Co Cu

(McLennan et al., 1993)

Fe Ti

ppm

ppm

Cr

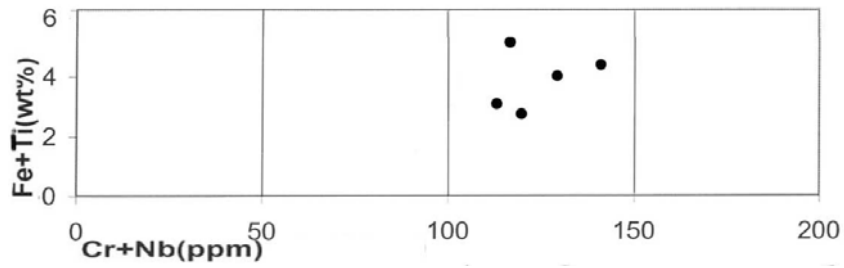
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U

(Maynard, 1983)

REE

Rb Sr

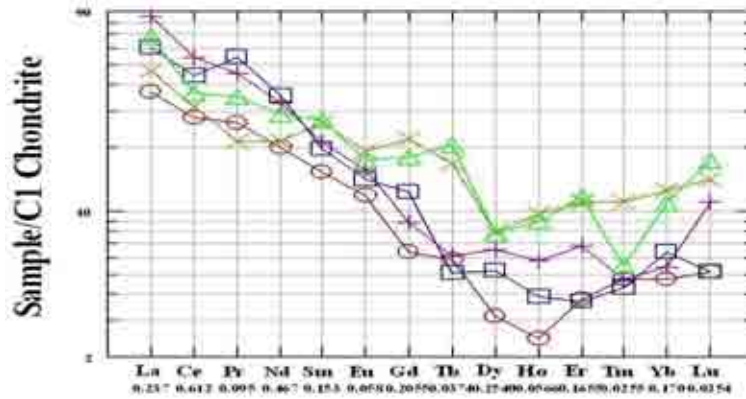


Dill et,al

Fe+Ti (wt%)/Ni+Nb(ppm)

ICP-ms

	Ce	Dy	Er	Eu	Gd	Ho	La	Lu	Nd	Pr	Sm	Tb	Tm	Yb	Sc	(Gd/Yb)CN	Eu/Eu*	(La/Yb)CN
TR-1	17.0	0.8	0.63	0.68	1.32	0.14	17.1	0.13	9.32	2.51	2.33	0.22	0.12	0.81	10.5	4.89	0.54	7.36
TR-2	27.1	1.32	0.61	0.82	2.51	0.22	17.3	0.13	16.6	5.16	3.04	0.19	0.11	1.09	7.38	1.86	0.42	8.86
TR-3	33.2	1.66	1.13	0.91	1.82	0.33	36	0.91	15.2	4.30	3.24	0.23	0.12	0.92	8.7	1.60	0.52	14.87
TB-1	19.2	2.01	1.82	1.12	4.52	0.55	25	0.36	10.0	2.04	4.06	0.63	0.28	1.13	16	1.72	0.39	8.5
TB-2	22.3	1.98	1.93	1.02	3.71	0.51	30.3	0.44	13.5	3.33	4.15	0.77	0.18	1.14	14	1.63	0.38	7.91
NASC	76.2	12.2	12.2	14.2	16.9	12.2	87.1	12.5	46.4	57.6	24.6	14.6	14.0	12.5	8.64	1.35	0.69	6.97
UC	66.8	9.19	9.24	10.1	12.4	9.40	81.7	8.40	36.5	51.8	19.4	11.0	9.25	8.87	11	1.40	0.65	9.21



(Cullers et al., 1979; Morey

& Setterholm, 1997)

(La/Yb)CN

REE

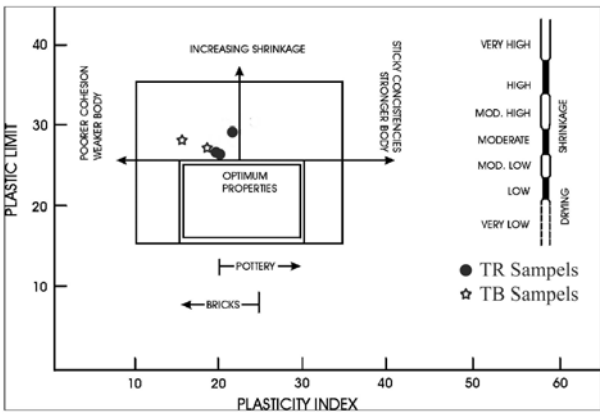
() LREE

C1

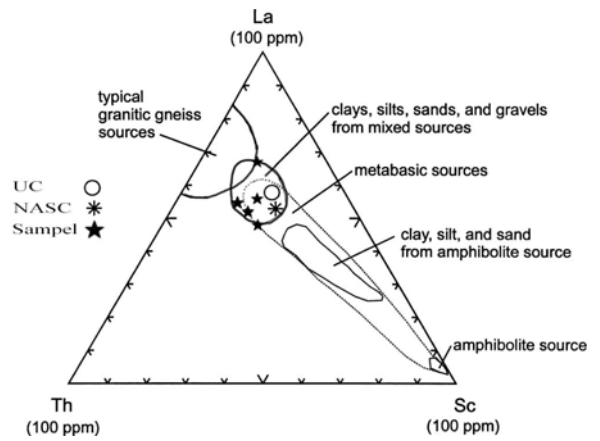
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(Belousova, 2002)

LREE



(Cassagrande,1948)



(Cullers,1994a,b)

(Murray, 2007)

....

(Munksgaad et al., 2003)

Eu
Cao Na₂O Eu

Eu (Awwiller,1994)

() (Cassagrande, 1948)

Eu LREE/HREE
La- (Cullers & Graft,1983)

() Sc-Th

(Cullers,1994)

(Adding Specific ASAQ

Amount of Quartz to clay soil samples)

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As , Cd , Pb , Se , Te ,

Sb Ti

%

)

%

.(b

Paleosol

Transforme

Fe+Ti/Cr+Nb

Zr ,Nb ,Y ,Th ,U

Th/U

(1994) Garcia et al

Common clay

Fire Clay

Refractory Clay

Eu

(1994a,b) Cullers

LREE

Mn

Eh

CIA

Co Cu

La-Sc-Th

U Cr

Ph

K/Rb

CIW

HREE

Fe

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(a) .

(b) .

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(a) .

(b) .

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