A NEW AREA OF ALKALINE ROCKS IN EASTERN PARAGUAY

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INTRODUCTION Alkaline rocks can be found in three major areas (northern, northeastern and central-eastern) of Eastern Paraguay. On die basis of geographic distribution and tectonic association, Livieres & Quade (1987) proposed inclusion of these outcrop areas different alkaline provinces: Alto Paraguay, Amambay and Central, respectively (Fig. 1). Presently, only the Central Province, clustering the largest number of occurrences, is the subject of systematic investigation. Available information on the Alto Paraguay and Amambay rocks is still scarce.

The western side of the Central Paraná Basin was the site of widespread magmatic activity from Early Cretaceous to Oligocene times in a region that experienced NE-SW trending crustal extension during the late Mesozoic (Comin-Chiaramonti *et al.* 1992, and therein references). Faulting formed a complex NW-trending graben, 25 - 45 km wide and 200 km long, in the Asuncion-Sapucai region (Degraff 1985), in which alkaline rocks occurring as dykes, volcanic domes, lava flows, shallow intrusive complexes and stocks cut or rest unconformably on Silurian and Mesozoic sandstones of the Caacupé Group and Misiones Formation, respectively. The region comprises Mesozoic tholeiitic volcanics of the Serra Geral Fomiation (130 Ma) on eastern side, K-alkaline rock-types (128 Ma) in central areas and Tertiary (61 - 39 Ma) ultra-alkaline (sodic) rocks on western side (Cormn-Chiaramonti ef *al.* 1991). •

In the Asuncion-Sapucai graben, K-alkaline rock-types are represented by two suites, i.e. tephrites to phonolites (and peralkaline phonolites) and alkali basalts to trachyphonolites; Na-alkaline rock-types include nephelinites (subofdinately ankaratrites) bearing mantle xenoliths (Demarchi *et al.* 1986) and. peralkaline phonolites.

Recently, during a field trip to study alkaline magmatism in Eastern Paraguay, alkaline rock-types, i.e. Na-nephelinites with and without mantle xenoliths and K-peralkaline phonolites were found near San Juan Bautista in Southern Paraguay (Fig. 2). The outcrops are associated with red sandstones of the Misiones Formation (Proyecto PAR 83/005, 1986) and show the following characteristics:

Estância Guavira-y (26°57.7'S, 57°06.7'W). Very small plug, 10 m high, of Na-nephelinitic rock-types having mantle xenoliths ind addition to clinopyroxene and orthopyroxene megacrysts.

Estância Ramirez (26°56.5'S, 57°10.0'W). NW-trending Na-nephelinitic dyke, 10 m.thick.

Cerro Caá Jhovy (26°43.2'S, 57°18.3'W). Small plug, 45 m high with an area of about 0.8 Km^2, of K-peralkaline phonolite.

This short paper correlates these new occurrences with the Tertiary Na-rich and Mesozoic K-rich rocks of the Central Province.

PETROGRAPHIC AND GEOCHEMICAL DATA Major and trace element contents of whole rocks were determined by X-ray fluorescence techniques (Bellieni *et al* 1983); microprobe mineral compositions were analyzed according to Comin-Chiaramonti *et al.* (1986) and Sm-Nd isotope compositions following the procedures of Comin-Chiaramonti et u& (1991). Representative compositions (whole rocks and mineral phase) are listed in tables 1 to 5.

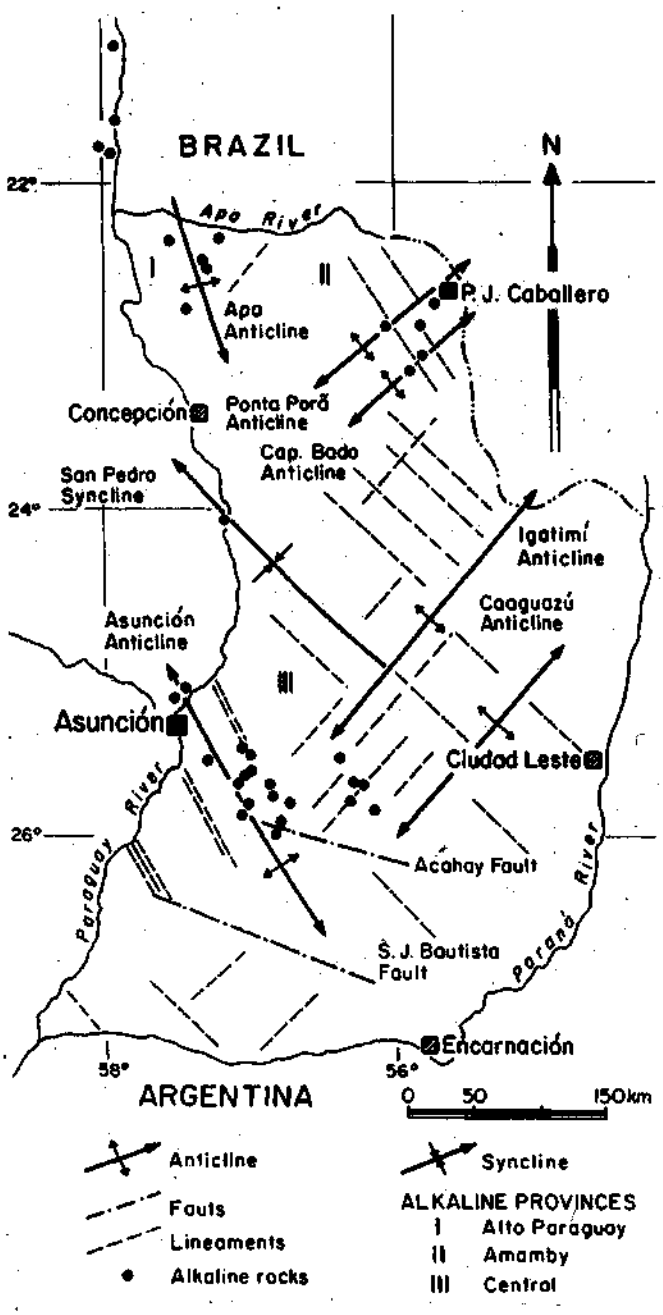

Figure 1 - General distribution of alkaline rocks of Paraguay (after Livieres & Quade 1987)
Figura 1 - Distribuição geral das rochas alcalinas do Paraguai segundo Livieres & Quade (1987)

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Table11 - Representative whol rock analyses (major elements in wt%, trace elements inppm) and isotopic data of rock-types from Southern Paraguay. Glass composition 9G) and calculated intergranular material (IG)from PS-569 renolith (%); mg = Mg/(Mg + Fe2+), assuming Fe_2O_3/FeO ratio = 0,20; A.L - $(Na_2O + K_2O)/Al_2O_3$ molar rath)

Tabela 1 - Análises representativas de rocha total (elementos nutates em % em peso, elementos traço em ppm) e dados isotópicos de tipos litológicos do sudeste do Paraguai. Composição do vidro (G) e material intergranular (IG) calculado do xenólito (PS-569); mg = Mg/(Mg + Fe^2+), assumindo razão FeA/FeO = 0,20; LA. = ($Na_2O + K_2O1/A1_2O_3$ razão molar)

			Estância Guavira-y				Estância Ramirez		Cerro Caá Jhovy
	SI-3	PS-569	PS-569 X	PS-569 G	PS-569 IG	SI-2	PS-570	PS-572	PS581
SiO_2	42.54	42.29	42.01	44.42	43.00	44.58	44.68	44.44	61.53
TiO_2	3.68	3.67	0.11	0.07	0.06	3.03	3.04	3.15	0.32
Al_2O_3	14.11	13.53	4.22	33.62	8.74	14.73	14.80	14.33	19.28
FeO_t	12.26	11.86	8.22	0.36	14.52	12.33	12.18	12.61	2.02
MnO	0.20	0.19	0.15	0.00	0.46	0.23	0.23	0.23	0.11
MgO	8.74	8.88	39.32	0.80	21.27	6.11	5.41	5.89	0.06
CaO	11.31	11.52	2.75	1.62	6.57	10.51	10.46	10.90	0.96
Na_2O	5.05	5.83	1.98	17.00	4.20	6.20	6.90	6.34	8.46
K_2O	1.20	1.30	0.34	2.75	0.65	1.33	1.32	1.16	7.11
P_2O_5	0.72	0.73	0.44	2.50	0.59	0.76	0.77	0.74	0.04
Total	99.81	99.80	99.53	103.14	100.46	99.81	99.79	99.89	
Cr	263	311	3240	0	3335	34	35	34	1
Ni	123	128	2048	0	446	36	30	50	7
Ba	774	878	185	-	-	904	841	747	44
Rb	73	91-46	-	-	42	58	43	216	
Sr	1085	951	432	-	-	1322	1446	1464	49
La	97	71	94	-	-	67	111	98	88
Ce	177	132	158	-	-	123	217	176	113
Nd	76	61	58	-	-	56	88	85	27
Zr	267	289	10	-	-	370	420	361	570
Y	29	33	20	-	-	41	46	46	19
Nb	77	72	18	-	-	93	101	82	52
mg	0.60	0.61	0.91	-	0.76	0.51	0.48	0.50	1.12
A.I.	0.68	0.81	0.85	0.92	0.87	0.79	0.86	0.82	1.12
$^{87}Sr/^{86}Sr$		0.70482±3	0.70484±2				0.70544±4		0.73176±2
$^{143}Nd/^{144}Nd$		0.512497±12	0.512432±6				0.51233±2		0.51210±2

Estância Guavira-y The investigated rock-types are nephelinites, according to the scheme of De La Roche *et al. (1*980), with mg values [mg = Mg/(Mg+Fe^{2+}), assuming Fe_2O_3 FeO = 0.20] ranging from 0.60 to 0.61. Texture is typically porphyritic with clinopyroxene olivine phenocrysts/ microphenpcrysts set in a hypocrytalline groundmass made up of glass, clinopyroxene, olivine, opaques and. foids.

Clinopyroxene and orthopyroxene megacrysts (not studied in this work), varying in size from a few mm to 10 cm, are widespread and occur in association with mantle xenoüths. These correspond to dunites with olivine and interstitial chromiferous spinel, largely infilled by glassy patches containing clinopyroxene and olivine microlites.

In the host nephelinites olivine phenocrysts/ microphenocrysts have mg ranging from 0.83 to 0.80 (in equilibrium with a liquidus with mg of 0.62 to 0.57, roughly corresponding to the mg of the whole rock; cf. Tab. 1), whereas olivine microlites show mg around 0.78. It should be noted that analogous olivine from the Assunción nephelinites (Comin-Chiaramonti *et al.* 1991) present *mg* values of 0.89-0.85 (phenocrysts), 0.82-0.77 (microphenocrysts) and 0.76-0.74 (groundmass).

Mg of clonopyroxene phenocrysts to microlites varies from 0.87 to 0.81; on the other hand, the *mg* range for clinopyroxene from the Asuncion nephelinites is 0.80 - 0.75. The opaques are titanian - magnetite (64 mole % ulvospinel), similar to those of the Asuncion rocks (60-65 mole % ulvospinel). Foids are nepheline (6% Q, 76% Ne, 18% Kp, in wt), showing no stoichiometry; groundmass foids of Asuncion nephelinites are almost stoichiometric with 84% Ne and 16% Kp (Comin-Chiaramonti *et al.* 1991).

The xenoliths have olivine of the dunitic assemblage with mg of 0.90 and spinel with Cr/(Cr+Al)=0.21 (atomic ratio); the olivine-spinel geothermometer (Fabries 1979) indicates a temperature of 944°C, reflecting subsolidus re-equilibration.

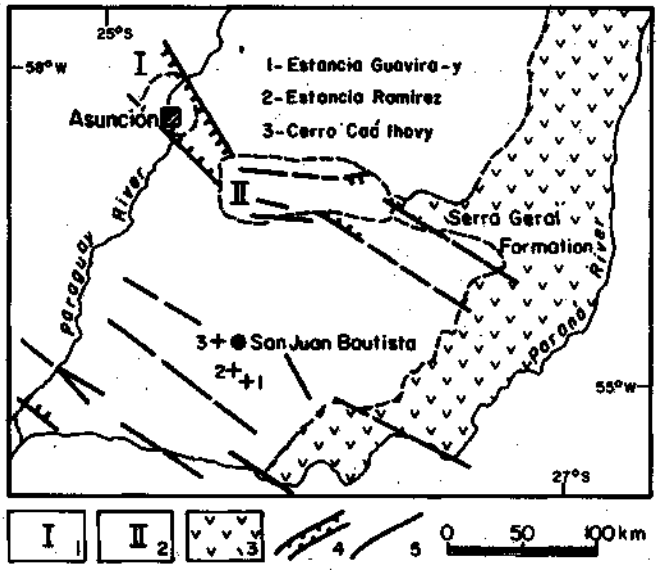


Figure 2 — Rifle tectonics and alkaline magmatism of central-eastern Paraguay (after Degraff 1985, Comin-Chiaramonti et al. *1992). Also shown are ike alkaline occurrences near San Juan Bautista. Legendas:* **1.** *Tertiary Na-alkaline rocks;* **2.** *Mesozoic K-alkaline rocks;* **3.** *Mesozoic tholeiitic basalts;* **4.** *Asuncion-Sapucai rift;* **5.** *Faults*

Figura 2 - Tectômica de rifle e magmatísmo alcalino da porção centro-oriental do Paraguai (segundo Degraff 1985, Comin-Chiaramonti *et al.* 1992). Mostram-se também as ocorrências alcalinas próximas à cidade de San Juan Bautista. Legendas: **1.** Rochas akalinas sódicas terciánas; **2.** Rochas alcalinas potássicas mesozóicas; **3.** Basaltos toleítos mesozóicos; **4.** Rifte Assunção-Sapucai; **5.** Falhas

*Table 2 - Representative analyses ofolivine. **P** = phenocrysts (c-core, r-rim); **mP** = microphenocrysts; **m** = groundmass phases; **M** - crystals oftheperídotític assemblage; **IG** - microcrystals in the glassy patches of mantle xenoliths, Crystallochemical formula on 4(0) basis*

Tabela 2 - Análises representativas de olivina. **P** = fenocristais (c-núcleo, r-borda); **mP** = microfenocristais; **m** = fases da massa fundamental; **M** = cristais da associação peridotítica; **IG** = microcristais na massa vítrea dos xenólitos mantélicos. Fórmula cristaloquímica na base de 4 (0)

	Estância Guavira-y						Estância Ramirez	
	Nephelinite PS-569				Xenolith Ps-569X		Nephelinite PS-570	
	Pc	Pr	mP	m	M	IG	mP	m
SiO_2	39.84	39.74	39.28	38.49	41.35	40.50	36.60	37.60
FeO	16.41	18.83	19.00	20.13	9.39	11.68	23.48	26.65
MnO	0.12	0.20	0.40	0.45	0.22	0.32	0.54	0.90
NiO	0.15	0.20	0.16	0.13	0.39	0.26	0.08	0.05
MgO	43.96	42.36	41.60	40.47	49.87	47.11	38.15	34.49
CaO	0.20	0.25	0.20	0.34	0.02	0.51	0.37	0.59
Total	100.68	101.58	100.64	100.66	101.24	100.38	101.19	100.28
Si	1.000	1.000	1.000	0.999	1.000	1.000	0.999	1.000
Fe^{2+}	0.344	0.396	0.404	0.435	0.190	0.241	0.507	0.593
Mn	0.003	0.004	0.009	0.010	0.004	0.007	0.012	0.020
Ni	0.003	0.004	0.003	0.003	0.008	0.005	0.002	0.001
Mg	1.644	1.589	1.578	1.557	1.797	1.734	1.471	0.698
Ca	0.005	0.007	0.005	0.009	0.001	0.013	0.010	0.017
Total	2.999	3.000	2.999	3.007	3.000	3.000	3.001	2.999
mg	0.83	0.80	0.80	0.78	0.90	0.88	0.74	0.70

Table 3 - Representative analyses of clinopywxenes. Symbols and letters as in table 2. Crystallochemical formula on 6 (O) basis; Fe_2O_3 and FeO recalculated by stoichiometry

Tabela 3 - Análises representativas de clinopiroxênios. Símbolos e letras na tabela 2. Fórmula cristaloquímica na base de 6 (0); Fe_2O_3 e FeO recalculados por estequiometria.

	Estância Guavira-y			Estância Ramirez		Cerro Caá Jhovy	
	PS-569			PS-569X	PS-570	PS-581	
	P	mP	m	IG	mP	m	
SiO_2	50.40	51.81	47.29	52.01	47.03	49.75	
TiO_2	1.34	0.73	2.71	0.15	2.57	0.95	
Al_2O_3	5.22	2.51	6.15	3.18	5.60	2.23	
Cr_2O_3	0.00	0.11	0.00	1.85	0.00	0.00	
Fe_2O_3	1.95	1.78	1.64	2.67	4.19	6.11	
FeO	3.72	5.34	5.31	1.65	3.86	8.61	
MnO	0.08	0.17	0.13	0.04	0.13	1.10	
NiO	0.07	0.00	0.03	0.12	0.00	0.00	
MgO	14.02	13.83	12.33	15.87	12.60	8.05	
CaO	23.36	23.22	23.09	22.36	23.50	21.64	
Na_2O	0.58	0.57	0.57	0.78	0.41	1.82	
K2O	0.00	0.02	0.07	0.00	0.03	0.03	
Total	100.74	100.09	99.29	100.68	99.49	100.29	
Si	1.844	1.919	1.779	1.893	1.761	1.903	
Al^{IV}	0.156	0.081	0.221	0.107	0.239	0.097	
Al^{VI}	0.069	0.029	0.052	0.029	0.008	0.004	
Ti	0.037	0.020	0.077	0.004	0.072	0.027	
Cr	0.000	0.003	0.001	0.053	0.000	0.000	
Fe^{3+}	0.054	0.050	0.046	0.073	0.118	0.176	
Fe^{2+}	0.114	0.165	0.167	0.050	0.121	0.275	
Mn	0.002	0.005	0.004	0.001	0.004	0.036	
Ni	0.002	0.000	0.001	0.003	0.000	0.000	
Mg	0.765	0.763	0.691	0.861	0.703	0.459	
Ca	0.916	0.922	0.931	0.872	0.943	0.887	
Na	0.041	0.041	0.027	0.054	0.030	0.135	
K	0.000	0.001	0.003	0.000	0.001	0.001	
Total	4.000	3.999	4.000	4.000	4.000	4.000	
Ca	46.5	48.4	50.6	46.9	49.9	48.4	
Mg	41.3	40.1	37.6	46.4	37.2	25.0	
$Fe^{2+}+Fe^{3+}+Mn$	9.2	11.5	11.8	6.7	12.9	26.6	
mg		0.87	0.82	0.81	0.95	0.85	0.63

Table 4 - Representative analyses of opaques. Symbols and letters as in table 2. Crystalhchemical formula on 4 (O) basis; Fe2O3 recalculated on ulvospinel basis

Tabela 4 - Análises representativas de opacos. Símbolos e letras como na tabela 2. Fórmula cristaloquímica na base de 4 (O); Fe2O3 e FeO recalculados na base de ulvoespinélio

	Estância Guavira-y		Estância Ramirez		Cerro Caá Jhovy
	PS-569	PS-569X		PS-570	PS-581
	m	M	mP	m	mP
SiO_2	0.10	0.00	0.10	1.26	0.17
TiO_2	20.05	0.06	17.96	15.62	21.76
Al_2O_3	3.69	49.12	4.65	5.91	0.00
Cr_2O_3	0.29	19.98	0.09	0.03	0.00
Fe_2O_3	27.40	1.28	29.55	28.64	26.93
FeO	42.75	9.49	43.56	41.74	46.04
MnO	0.66	0.12	0.90	0.87	5.50
MgO	4.34	19.72	2.57	2.95	0.02
NiO	0.09	0.00	0.06	0.00	0.00
CaO	0.11	0.00	0.03	0.23	0.03
Total	99.48	99.77	99.47	97-25	100.42
Si	0.003	0.000	0.004	0.046	0.006
Ti	0.543	0.001	0.491	0.431	0.614
Al	0.157	1.549	0.199	0.2558	0.000
Cr	0.008	0.423	0.003	0.001	0.000
Fe^{3+}	0.0742	0.026	0.808	0.790	0.760
Fe^{2+}	1.287	0.212	1.325	1.280	1.443
Mn	0.020	0.003	0.028	0.027	0.175
Mg	0.233	0.786	0.139	0.161	0.001
Ni	0.003	0.000	0.002	0.000	0.000
Ca	0.004	0.000	0.001	0.009	0.001
Total	3.000	3.000	3.000	3.000	3.000
Ulv.mol%	64.4	0.2	59.5	57.8	71.0

Olivine and clinopyroxene microlites from the glassy patches have mg of 0.88 and 0.95, respectively.

Mass balance calculations for the xenoliths reveal that they are composed (ΣR2 = 0.041-0.015) of 56.7% of peridotitic assemblage (55.8% Ol + 0.95 Sp) and of 43.7% of intergranular material (21.9% Ol, 11.5% Cpx and 10.3% glass).

Assuming that the infilled material is representative to some extent of a primary liquid, the calculated liquid (21.9% Ol, 11.5% Cpx, 10.3% glass) has mg of 0.76, corresponding, in equilibrium conditions, to an olivine with *mg* of 0.91, this being a value similar to that of the peridotitic assemblage. But, in this case, the olivine microlites are not in equilibrium with such a liquid, and it is believed that they represent the product of a mor evolved liquid, having presumably Cpx as the first crystallizing phase. Moreover, die mass balance (2R2>>1) shows clearly that the host nephelinites cannot be derived from the calculated liquid. On the whole, the mantle xenoliths from Estância Guavira-y are quite different respect to the Asuncion nephelinitex, which show Ol-Opx-Cpx-Sp assemblages grading from dunites to Iherzolites (Demarchi *et al* 1986).

Estância Ramirez The sampled rocks are nephelinites with mg in the range of 0.51-0.48. Texture is porphyritic with clinopyroxene *(mg* = 0.85), olivine *(mg* = 0.74) and Ti-magnetite (59.5 mole % ulvospinel) microphenocrysts set in a hypohyaline groundmass consisting of otivine (mg = 0.70), opaques (57.8 mole % ulvospinel) and foids (15% Q, 73% Ne, 12% Kp, in wt) microlites. The relatively low mg value in addition to the low Cr and Ni contents (cf. Tab. 1) indicate that Estância Ramirez nephelinitres represent a derivative magma. Mass balance (major elements) calculations show the impossibility of deriving this rock-type from the Estância Guavira-y nephelinites through fractional crystallization (RR2 = 0.71), a process requiring the extraction of olivine (6%), clinopyroxene (27%), nepheline (17%), titanian-magnetite (6%) and apatite (1%). Additionally, the incompatible trace element calculated/observed ratios (Rayleigh fractionation; partition coefficients after Bristow 1984) display a random range between 0.6 and 2.4, suggesting the existence of an independent parental magma.

Thus, geochemical evidence points to distinctive forerunners for the San Juan Bautista nephelinites. Moreover, the mineral chemistry exhibits different features respecto to the Asuncion nephelinites. As a matter of fact, if comparison is made on the basis of major and trace elements, the San Juan Bautista nephelinites are characterized by lower SiO_2, $A1_2O_3$, P_2O_5, Cr, Ni, Ba, Nb and higher TiO_2 FeOt and Rb contents (Fig. 3).

Cerro Caá Jhovy The peralkaline phonolite is porphyritic with alkali feldspar phenocrysts (44% Or, 55% Ab, in wt) and opaques microphenocrysts (71 mole % ulvospinel) set in a glassy matrix of clinopyroxene (10% acmitic component) and feldspar microlites (45% Or, 54% Ab, in wt). Five chemical analyses of samples collected at different levels of the plug (P. Comin-Chiaramonti, unpublished data) indicate that the outcrop is very homogeneous, die variations falling within the limits of the analytical error.

The K_2O/Na_2O (wt) ratio is 0.84 and lies in the main range for the K-alkaline rock-types of the Asunción-Sapucai graben (0.6-4.0: Comin-Chiaramonti *et al.* 1992). Main differences with respect to these rocks deal with the lower $A1_2O_3$, Sr and Zr and higher TiO_2, K_2O and Rb contents of the Cerro Caá Jhovy phonolite (Fig. 4).

Sr and Nd isotopes Preliminary data show that "Sr/ "Sr ratios for the host nephelinite and mantle xenoliths from Estância Guavira-y are 0.70482 ± 3 and 0.70484 ± 2, respectively (Tab. 1). Regarding the latter the isotopic ratio probably reflects the contribution of the infilled glassy material, indicating that the source for both host nephelinite and infilled material is isotopically the same.

Quite different is the isotopic ratio for the Estância Ramirez outcrop, $^{87}Sr/^{86}Sr$=0.70544 ± 4. On the other hand, the CerroCaa Jhovy plug displays a very high $^{87}Sr/^{86}Sr$ ratio of 0.73176 ± 2.

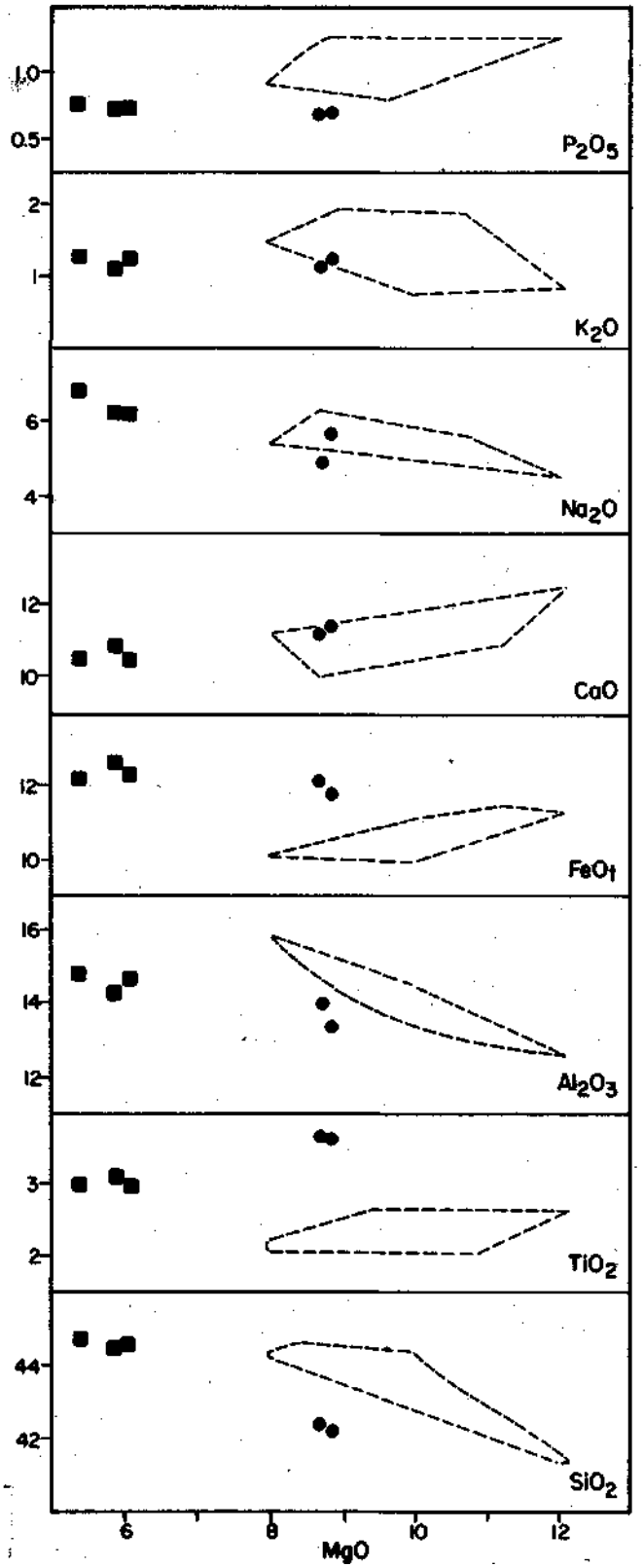


Figure 3 - MgO (wt%) vs. (a) major (wt%) and (b) trace element (ppm) diagrams for the nephelinites of the San Juan Bautista area. Dots, Estância Guavira-y; squares, Estância Ramirez; outlined area represents the field of the Asuncion nephelinites (Comin-Chiaramontietal. 1991)
Figura 3 - Diagramas de vai ição MgO *(%* em peso) vs. (a) elementos maiores *(%* em peso) e (b) traços ppm) para os nefelinitos da área de San Juan Bauüsta. Círculos, Estância Guavira-y; quadrados, Estância Ramirez; área assinalada representa o campo dos nefelinitos de Assunção (Comin-Chiaramonti *et al.* 1991)

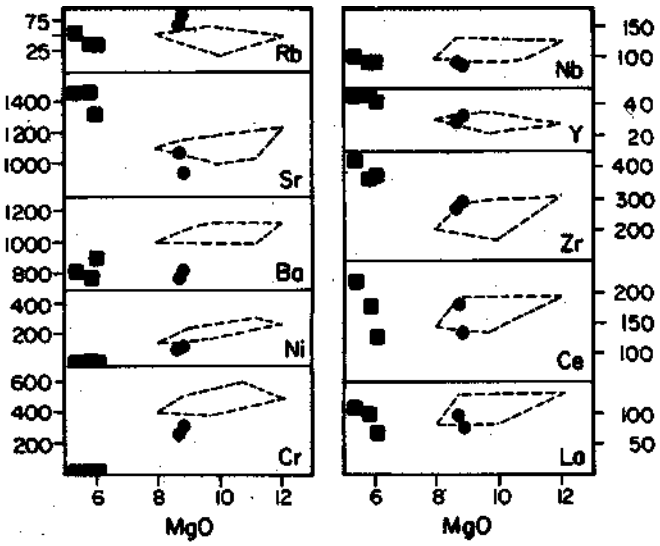


Table 5 - Representative analyses of folds (PS-569 and PS-570) and alkali feldspars (Ps-581). Symbols and letters an in table 2. Crystallochemical formula on 8 basis
Tabela 5 - Análises representativas de fóides (PS-569 e PS-570) e fedspatos alcalinos (PS-581). Símbolos e letras como na tabela 2. Fórmula cristaloquímica na base de 8 (0)

	Estância Guavira-y PS-569	Estância Ramirez PS-570	Cerro Caá Jhovy PS-581	
	m	m	P	m
SiO_2	44.16	47.78	66.73	66.19
Al_2O_3	33.68	31.50	18.91	18.73
Fe_2O_3	1.38	0.77	0.19	1.34
MnO	0.02	0.03	0.00	0.00
CaO	1.71	1.01	0.08	0.19
BaO	0.07	0.05	0.15	0.00
SrO	0.04	0.05	0.00	0.00
Na_2O	14.91	14.28	6.52	6.36
K_2O	4.86	3.27	7.45	7.52
Total	100.83	98.74	100.03	99.33
Si	2.092	2.259	2.994	2.968
Al	1.881	1.756	1.000	1.021
Fe	0.049	0.027	0.006	0.012
Mn	0.001	0.001	0.000	0.000
Ca	0.87	0.051	0.004	0.008
Ba	0.001	0.001	0.003	0.000
Sr	0.001	0.001	0.000	0.000
Na	1.369	1.309	1.567	0.570
K	0.294	0.197	0.426	0.443
Total	5.775	5.629	5.000	5.022
Q	5.8	15.2		
Ne	76.1	72.6		
Kp	18.1	12.2		

At The present time, no age data are available for the alkaline rocks of Southwertern Paraguay which could provide initial $^{87}Sr/^{86}Sr$ (RO) ratios. But if the relationship between Ro and age (Ma) relative to the Asuncion nephelinites holds true (Comin-Chiaramonti et al. 1991), itwould be possible to derive age values by applying the equations {Ro = 0.702904 + 1.687 10 - 5 Ma and {Ro = $(^{87}Sr/^{86}Sr)_{meas}$ - $(Rb/Sr)_{meas}$ 4.1110 - 5 Ma, as inferred by those authors, as follows:

		Age(Ma)	Ro
PS-569	Estância Guavira-y	92.1	0.70446
PS-569X	Estância Guavira-y	91.3	0.70444
PS-570	Estância Ramirez	137.0	0.70521
PS581	Cerro Caá Jhovy	145.7	0.70536

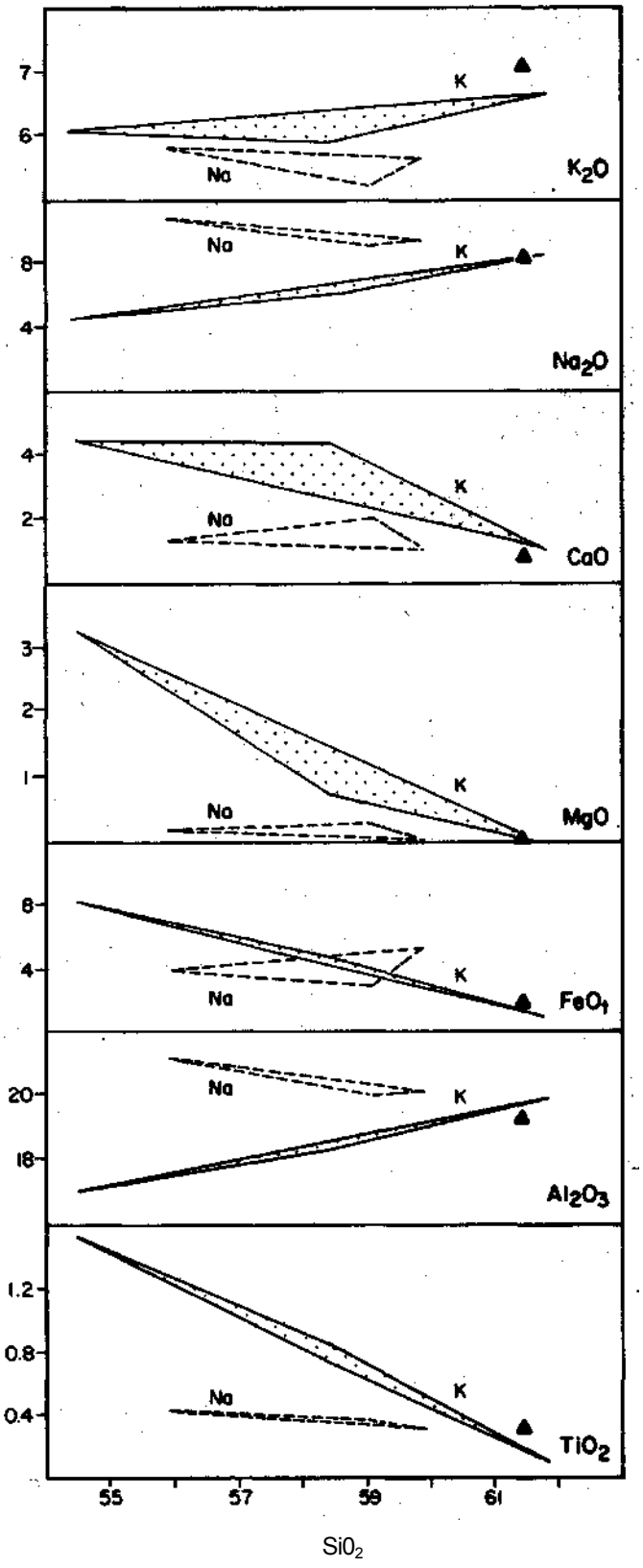
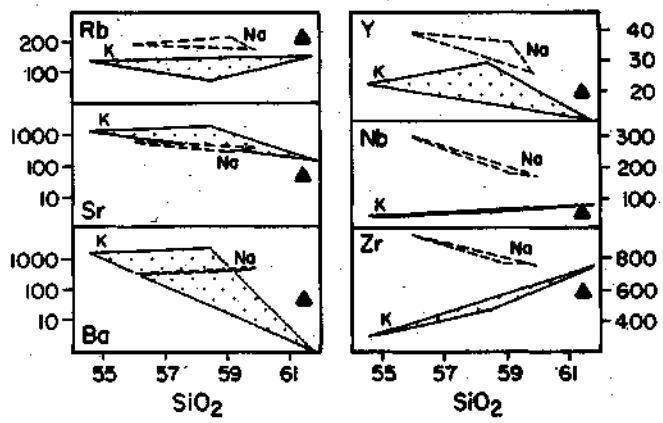


Figure 4-SiO_2 (wt%) vs. (a) major (wt%) and(B) trace element (ppm) diagrams for the Cerro Caá Jhovy phonolite. Also indicated are the fields for K-alkaline (dots) and Na-aJkaline (dashed) rock-types of the Asunción-Sapucai Graben area

Figura 4 - Diagramas de variação SiO_2 (% em peso) vs. (a) elementos maiores (% em peso) e (b) traços (ppm) para o fonolito do Certo Caá Jhovy. Mostram-se também os campos para as litologias alcalinas potássicas e sódicas da área do Graben Assunção-Sapucai



The $^{143}Nd/^{144}Nd$ isotopic ratios for Estância Guavira-y host nephelinite and xenoliths, Estância Ramirez nephelinite and Cerro Caá Jhovy phonolite indicate isotopically distinct sources with respect to the other alkaline rock-types of Central-Eastern Paraguay (Fig. 5). For the Cerro Caá Jhovy plug, lying outside the main array for Eastern Paraguay occurrences, a younger age and crustal contamination cannot be disregarded.

FINAL REMARKS The alkaline occurrences of Southern Paraguay exhibit mineralogical, petrochemical and geochemical characteristics which are quite distinctive from those shown by the alkaline rock-types from Central-Eastern Paraguay (i.e. Asunción-Sapucai graben).

If the estimated values for ages can be confirmed, field evidence appear to suggest that taphrogenetic events spanning the entire Early Cretaceous affected an area of Southern Paraguay, parallel to the Asunción-Sapucai graben and also characterized by direct fault (degraff 1985).

Probably another rift structure, also induced by extensional Mesozoic tectonics and lying south of the Asunción-Sapucai graben, is present in Southern Paraguay. Other alkaline complexes may occur in association with this structure.

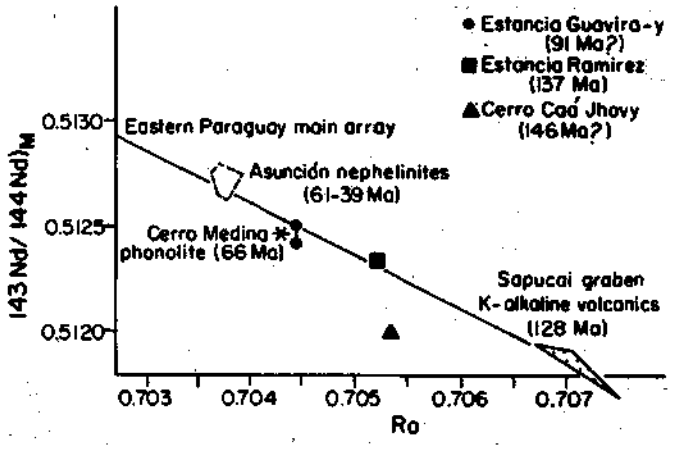


Figure 5-Ro (initial $^{87}Sr/^{86}Sr$ isotopic ratios) vs. (measured isotopic ratios) for the alkaline occurrences of Eastern Paraguay. Also shown is the mantle array (n - 0.9901) for the different rock-types

Figura 5 - Gráfico reunindo Ro (razões isotópicas iniciais $^{87}Sr/86Sr$) e $^{143}Nd/^{144}Nd$ (razoes isotópicas medidas) para as ocorrências alcalinas do Paraguai Oriental. O arranjo mantélico (n = 0,9901) para as diferentes litologias alcalinas é também mostrado.

Detailed studies however will be necessary not only to confirm this hypothesis but also to explore the possibility that mantle xenoliths from the San Juan Bautista and Asuncion areas may be related to different mantle sources.

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