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ISOTOPIC STUDY OF IGNEOUS AND METAMORPHIC ROCKS OF COMALLO-PASO FLORES, RÍO NEGRO, ARGENTINA

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INTRODUCTION

In the region that extends northwards from Comallo to Paso Flores in the Limay river (Fig.1), igneous and metamorphic rocks forming the Crystalline Basement of the area crop out. This basement outcrops discontinuously in the southwest of the North-Patagonian Massif and is referred to a Cushamen and Mamil Choique Formations. According to stratigraphic records, the youngest age of these rocks dates back to the Pre-Triassic and Upper Pre-Permian. The few isotopic ages previously obtained yielded significant values within the Carboniferous (K-Ar method) and Ordovician to Devonian (Rb-Sr).

Metamorphic and migmatitic rocks has been distinguished in the Crystalline Basement. It has been referred to as Cushamen and Mamil Choique Formations (Volkheimer, 1964; Ravazzoli and Sesana, 1977) and type area is near the 42° S. The outcrops of Comallo-to-Paso Flores region (Nullo, 1979; González, 1998) have also been assigned to these units. The age of these rock complexes has led to doubts and discusssion, and differente authors located them in the Precambrian, Lower Paleozoic and Upper Paleozoic. The stratigraphic control of the region under study determines that the basement rocks date back to the Pre-Upper Triassic since sedimentites and fossil flora overlie in angular unconformity. Moreover, Rb/Sr data on undeformed and intrusive granitoids in deformed rocks from the Basement yielded an Uper Permian age (Pankhurst *et al.*,1992).

Previous radiometric analyses of these basement rocks yielded a K/Ar age of 316 ± 5 Ma to 353 ± 4 Ma, and Rb/Sr age of 412 Ma in the Limay region (Varela *et al.*, 1991). In Río Chico, Rb/Sr isochrons yielded values of 439 ± 10 Ma and 387 ± 17 Ma (Dalla Salda *et al.*, 1994) and in Gastre, according to Rb/Sr isochrons, 346 ± 35 Ma and 269 ± 27 Ma (Rapela *et al.*, 1992).

In the present work, we provide and interpret new data for the Comallo-Paso Flores region by the K/Ar and Rb/Sr methods, as well as the first data obtained by U/Pb and Sm/Nd methods.

RESULTS

K/Ar METHOD

Ages were obtained on samples of tonalite and granitic micas from Paso Flores, Loma Carhué, Loma Miranda and Comallo (Fig.3). In Paso Flores, rocks are granodioritic and tonalitic gneisses (AB 25; 40° 37' 19"S - 70° 37' 51"W), with marked foliation, wel-preserved biotite and showing some deformation by flexure in the major crystals. The age obtained was 261 ± 6 Ma In Loma Carhué we found exposure of biotite-muscovite-garnet schists cut by pegmatoid veins; muscovites dated from such pegmatoids (AB 26A; 40° 54' 59"S - 70° 36' 33"W) yielded an age of 254 ± 6 Ma. Two samples were obtained from the eastern end of Loma Miranda. The first sample was a foliated leucogranite (AB 51; 40° 54' 51"S - 70° 13' 31"W), with fresh biotite-muscovite association. Biotite yielded an age of 243 ± 5 Ma. Leucogranites contain pegmatoids veins with abundant muscovite; this muscovite (AB 50; 40° 55' 16"S - 70° 13' 27"W) yielded an age of 235 ± 8 Ma. Finally, from a tonalite cropping out slightly to the East of Comallo (AB 27A; 41° 01' 50"S - 70° 14' 18"W) biotite concentrated gave an age of 262 ± 7 Ma.

Rb/Sr METHOD

A set of eighth samples of granodiorites exposed to the East of Comallo, and another set of

nine samples of leucogranites from Loma Miranda, were processed (whole rock) yielding negative results. In both cases, the $^{87}Rb/^{86}Sr$ vs $^{87}Sr/^{86}Sr$ diagram evidences dispersion due to the opening of the isotopic system caused by the strong deformation affecting the region.

U/Pb METHOD

Zircons were concentrated out of three samples, and fractions of different magnetic response were separated.

Five fractions of tonalitic gneiss from Paso Flores (AB 121; 40° 37' 19"S - 70° 37' 51"W) yielded an upper interception with an age of 292 ± 9 Ma (Fig.2 and 3).

For Loma Miranda, we separated zircons from a foliated tonalite (AB 120; 40° 58' 16"S - 70° 23'18"W), which contained rotated major crystals of plagioclase surrounded by biotite, and recrystallized quartz-feldspar mosaics, denoting deformation in high greenschist facies. Four fractions define a lower interception of an age of 269 ± 13 Ma (Fig.2 and 3).

A biotitic tonalite (AB 27; 41° 01' 50"S - 70° 14' 18"W) was dated from Comallo, evidencing scarce deformation and containing euhedral to subhedral plagioclase, interstitial quartz with the shape of subgrains with incipient recrystallization, abundant biotite, partially intergrown with muscovite. Four fractions of zircons were processed and three of them defined an upper interception of 334 ± 28 Ma. The fraction M(-1) was not utilized in age calculation (Fig.2 and 3).

Sm/Nd METHOD

Out of two samples, one of them was a tonalite from the outcrops to the East of Comallo (AB 27C; 41° 01' 50"S - 70° 14' 18"W) and yielded a TDM model age of 1395 ± 52 Ma. The other sample was a foliated tonalite from Loma Miranda (AB 120; 40° 58' 16"S – 70° 23' 18" W) and gave a TDM model age of 1165 ± 53 Ma.

DISCUSSION

The radiometric data obtained contribute mainly to the knowledge of the deformed igneous complexes in the Limay region and have been correlated with those of Mamil Choique Formation. In an indirect way, these data give a youngest age for the metamorphic rocks of the Cushamen Formation, wich constitute the country rock.

The crustal layer studied clearly showed that 235 ± 8 Ma to 262 ± 7 Ma (Middle Triassic to Upper Permian) is the youngest age of the last ductile regional deformation, followed by a cooling process probably associated to regional uplifting.

Failure in obtaining isochrons by the Rb/Sr method would be related to the high degree of deformation and the opening of the isotopic system to whole rock scale. At the same time, it is a warning about the validity of earlier ages obtained with this method, both in the zone bordering the Limay river and in the type zone of Río Chico-Mamil Choique.

The yielded U/Pb data represent plutonic crystallization ages possibly ranging from 334 ± 28 Ma to 269 ± 13 Ma (Upper Carboniferous – Lower Permian), and tentatively related to the activity of a magmatic arc.

The Sm/Nd TDM model ages of 1,2 to 1,4 Ga fall within the range obtained by this method from rocks of the Patagonian crust. Together, they probably indicate the Mesoproterozoic as the time these granitic materials were extracted from the mantle.

The data obtained revalue the importance of the Gondwanic geodynamic activity (Gondwanic cycle, Carboniferous to Triassic) in the North-Patagonia. The presence of important undeformed plutonic and volcano-plutonic associations of the Upper Permian to Lower Triassic (259 to 239 Ma; Llambías *et al.*, 1984; Pankhurst *et al.*, 1992) are now interpreted as the response to a significant crustal thickening produced by geodynamic events, where important associations of magmatic arc underwent compression and metamorphism (Upper Carboniferous - Lower Permian, according to the data contributed by this work), and which formed the Cushamen and Mamil Choique Formations.

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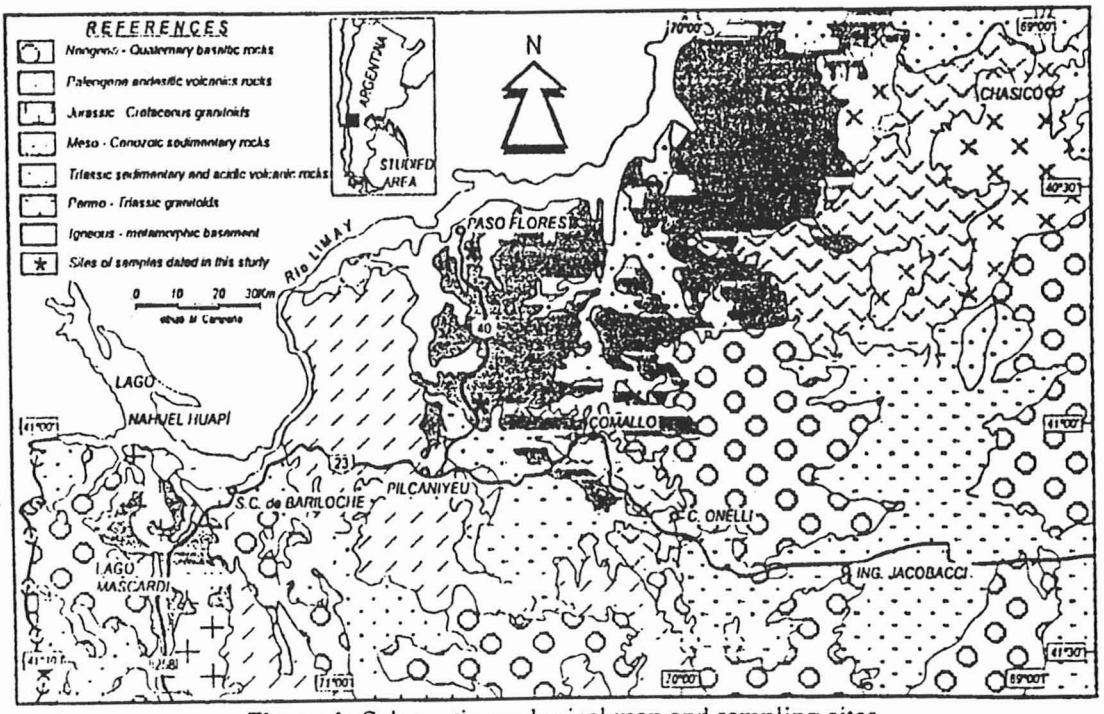

Figure 1: Schematic geological map and sampling sites.

K-Ar METHOD

SAMPLE	ROCK /MATERIAL	K %	^{40}Ar Rad. (10^{-6} cc STP/g)	^{40}Ar Atm. %	Age Ma
AB 25 – SPK 7294	Granodioritic gneiss / biotite	6.7045	73.25	5.86	261 ± 6
AB 26A – SPK 7295	Pegmatite / muscovite	6.9244	73.28	14.37	254 ± 6
AB 51 – SPK 6366	Leucogranite / biotite	7.0859	71.66	5.09	243 ± 5
AB 50 – SPK 7372	Pegmatite / muscovite	8.1629	79.70	7.10	235 ± 8
AB 27A - SPK 7350	Tonalite / biotite	7.1875	78.55	3.64	262 ± 7

ANALYTICAL DATA FOR ZIRCONS FROM COMALLO-PASO FLORES AREA

FRACTION (1)	WEIGHT	CONCENTRATION (ppm) (2)		OBSERVED (3)	ATOMIC RATIOS (4)			AGES (5)		
	(g)	U	Pb	$^{206}Pb/^{204}Pb$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$
COMALLO										
AB27 NM(-1)	0.001060	448	21.05	1247.19	0.045700	0.336026	0.0533275	288	294	343
AB27 M(-1)	0.001424	553	24.92	1828.49	0.044705	0.323810	0.0525325	282	285	309
AB27 M(0)	0.001316	554	24.52	1577.54	0.043541	0.318922	0.0531232	275	281	334
AB27 M(1)	0.001331	596	25.28	1197.75	0.041385	0.318922	0.0528316	261	268	322
L. MIRANDA										
AB120NM(-6)	0.00010	800	43.93	568.64	0.051988	0.469653	0.0657726	320	385	799
AB120M(-5)	0.00070	407	18.91	886.02	0.044849	0.333842	0.054176	281	292	378
AB120M(-4)	0.00063	231	10.38	977.33	0.043103	0.314233	0.0528774	272	277	323
AB120M(-3)	0.00088	381	16.97	951.38	0.042549	0.307074	0.0523419	269	272	301
P. FLORES										
AB121M(-3)	0.00094	495	22.56	589.17	0.042735	0.307229	0.0521401	270	272	292
AB121M(-4)	0.00096	545	24.87	591.09	0.042682	0.308355	0.0523961	269	273	303
AB121M(-2)	0.00090	214	9.93	700.04	0.044569	0.319414	0.0519772	281	281	284
AB121M(-4)R	0.00223	414	18.25	1064.62	0.042858	0.307233	0.0519916	270	272	285
AB121M(-5)	0.00445	358	19.12	447.79	0.048072	0.345997	0.0522015	303	302	294

1: Non magnetic fractions (Frantz separator at 1.5 amp. current); 2: Total U and Pb concentrations corrected for analytical blank; 3: Not corrected for blank or non-radiogenic Pb; 4: Radiogenic Pb corrected for blank and initial Pb; U corrected for blank; 5: Ages given in Ma using Ludwig Isoplot Program (1993), decay constants recommended by Steiger and Jäger (1977).

Figure 3: Analytical results.