

# ISOTOPIC DATING ON THE CRYSTALLINE BASEMENT ROCKS OF THE BARILOCHE REGION, RIO NEGRO, ARGENTINA

Miguel A.S.Basei<sup>1</sup>, Benjamín B.Brito Neves<sup>1</sup>, Ricardo Varela<sup>2</sup>, Wilson Teixeira<sup>1</sup>, Oswaldo Siga Jr.<sup>1</sup>, Ana M.Sato<sup>2</sup> & Carlos A.Cingolani<sup>2</sup>

<sup>1</sup>Instituto de Geociências, Universidade de Sao Paulo, Caixa Postal 11348. 05422-970 Sao Paulo, SP, Brasil. E-mail: baseimas@usp.br

<sup>2</sup>Centro de Investigaciones Geológicas, UNLP-CONICET. Calle 1 N° 644. 1900 La Plata, Argentina. E-mail: varela@cig.museo.unlp.edu.ar

**Keywords:** North-Patagonian Cordillera, Basement, Isotopic ages, Geotectonics

## INTRODUCTION

South of Bariloche, one of the remnants from the Crystalline Basement of the North-Patagonian Cordillera crops out. They appear on the eastern-Andean side as tectonic slices dipping West, in an environment abundant in granitoids and volcanics of a magmatic belt essentially developed during the Cretaceous and Tertiary. Doubts have arisen with regard to the age of the basement, and in general it has

been assigned to the Precambrian. Earlier radiometric information, together with the present work, provides new data enabling more accurate chronostratigraphic position and geotectonic relevance.

The main basement exposures considered in this work are those crossing the 258 National Road, on the coast of Gutiérrez, Mascardi and Guillermo lakes, and further to the south, in the minor outcrops near Villegas river (Fig.1).

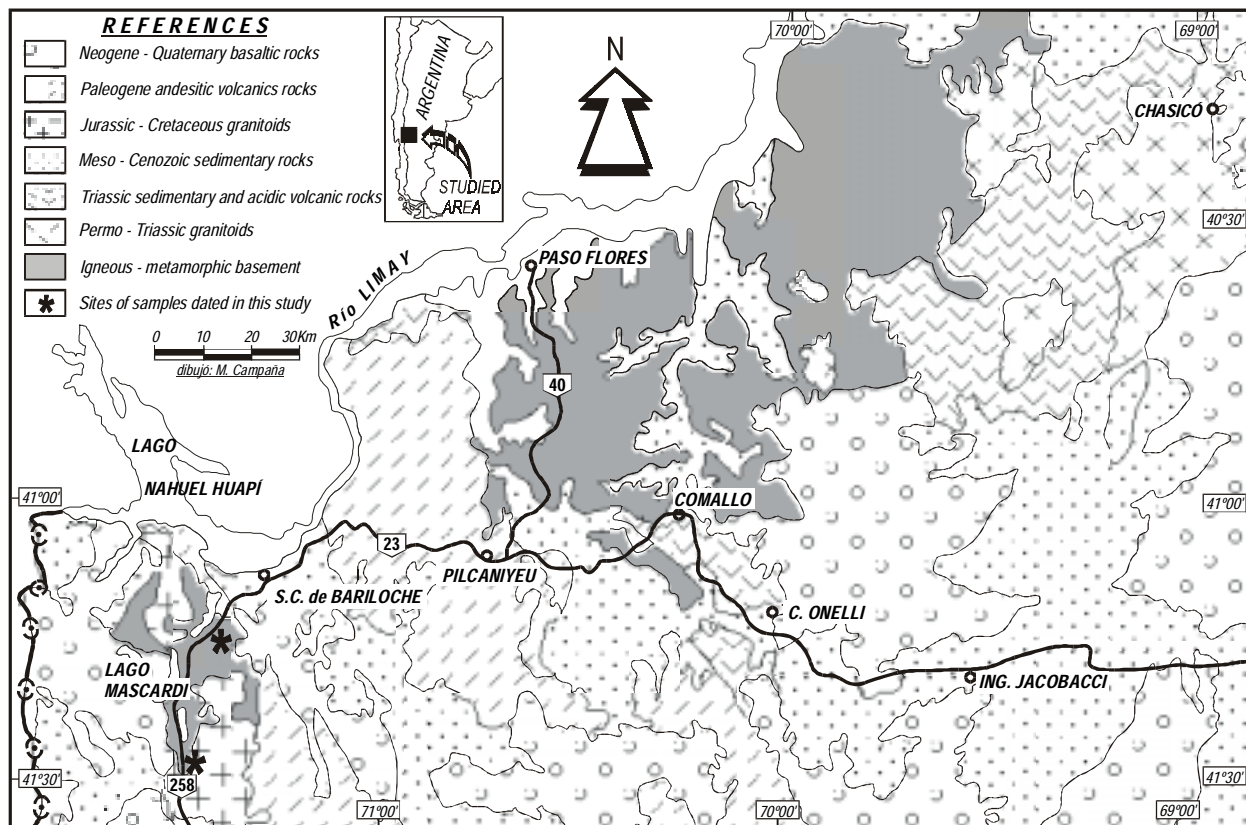


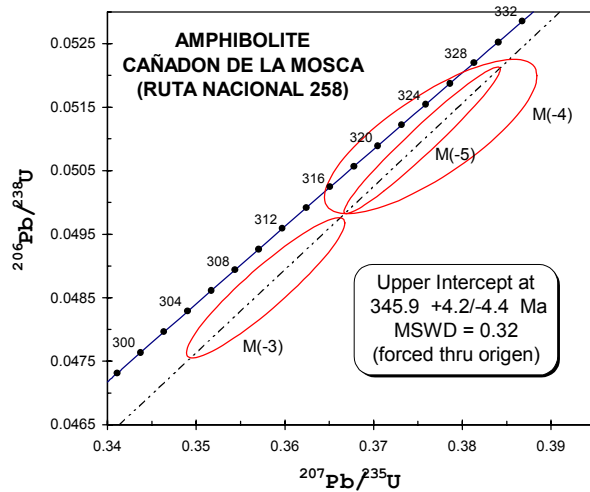
Figure 1: Schematic geological map and sampling sites.

The basement was mapped on Geological Sheet 40b and 41b (Feruglio,1947; González

Bonorino,1944) and correlated with the Upper Paleozoic in the Cordillera of the Chilean coast

(González Bonorino, 1973 and 1979). K/Ar data (chloritized biotite) on a muscovite-garnet schist from Cerro Catedral yielded a value of  $240 \pm 30$  Ma (Toubes and Spikermann, 1973). On the other hand, a reference isochron of 300 Ma was reported by Halpern et al. (1975) for quartz-mica schists from Lago Gutiérrez. Later, Dalla Salda et al. (1991) provided a detailed description of composition and structure, and characterized them as an association of schists, gneisses, migmatites and amphibolites, with minor intrusions of tonalitic and granodioritic composition. A Rb/Sr isochron for gneisses and tonalite-granodiorite yields an age of  $727 \pm 48$  Ma, and K/Ar ages on amphibolites were of  $344 \pm 30$  Ma and  $329 \pm 24$  Ma. The authors above mentioned tentatively correlated the rocks from the Bariloche basement with the Colohuincul Formation of the region of San Martín de los Andes.

The internal structure of the basement is the result of two phases of main deformation, with foliation planes oriented  $N75^\circ/31^\circ S$  and  $N130^\circ/61^\circ NE$ , which have caused interference figures. It is worth adding that on the coast of Gutiérrez lake intrusive relation in metamorphic rocks has been proved to be present in a granodioritic body by means of a chilled margin.



## RESULTS

In order to improve the knowledge of the Crystalline Basement age, dating was performed by means of the K/Ar, Rb/Sr, U/Pb and Sm/Nd methods.

### K/Ar METHOD

Three ages were obtained from the Gutiérrez lake, including metamorphic rocks and intrusive granodiorite (Fig.3). In the first case, muscovite was dated from a quartz-muscovite-chlorite-garnet schist (SPK 7367, AB65;  $41^\circ 12' 50'' S - 71^\circ 24' 08'' W$ ), with an age value of  $230 \pm 5$  Ma. Dating from tonalitic gneisses (SPK 7253, AB19B;  $41^\circ 13' 14'' S - 71^\circ 24' 43'' W$ ) yields an age of  $205 \pm 6$  Ma. Biotite age  $140 \pm 6$  Ma was dated from the granodioritic intrusive in the basement rocks (SPK 7252, AB23A;  $41^\circ 15' 58'' S - 71^\circ 29' 34'' W$ ).

### Rb/Sr METHOD

The K/Ar analyzed units were also assessed by this method. We processed rocks complexes – schists, gneisses, granodiorites – from outcrops on the borders of Gutiérrez lake. For the three cases, the isochron diagram plotting evidenced openings of the isotopic system, no significant alignments being achieved.

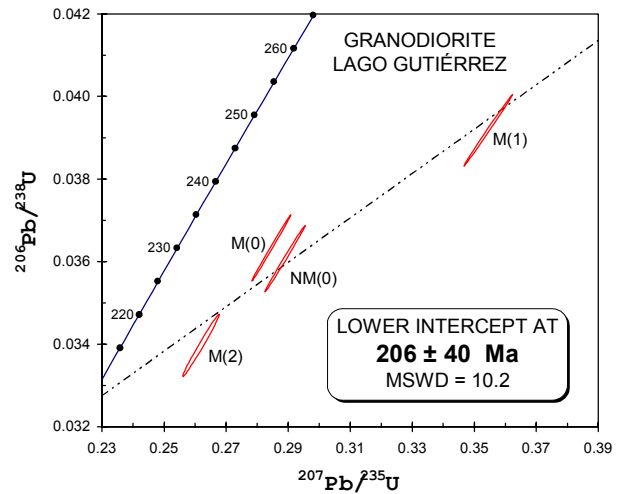


Figure 2: Concordia diagrams.

### U/Pb METHOD

Fractions of zircons of different magnetic response were concentrated from foliated amphibolite and a granodioritic gneiss-intrusive rocks. Amphibolite was collected at the Cañadón de la Mosca (Fig.1), 258 National Road (AB 123,  $41^\circ 31' 41'' S - 71^\circ 27' 30'' W$ ), showing no contact-

relationship with other basement rocks. Foliation is characterized by elongation of amphibole and plagioclase in a rock poor in quartz, apatite and zircon. Three fractions of zircons define a good straight line, whose upper interception in the concordia diagram yielded an age of  $345.9 +4.2/-4.4$  Ma (Fig.2 and 3). Granodiorite show granular texture,

with zoned plagioclase, amphibole, biotite, quartz and K-feldspar. It forms part of the intrusion exposed on the borders of the Gutiérrez lake (Fig.1; AB23, 41° 15' 58"S – 71° 29' 34"W). Four fractions of zircons plotted on the concordia diagram define a lower

interception of  $206 \pm 40$  Ma (Fig. 2 and 3).

#### Sm/Nd METHOD

Both U/Pb-samples were processed for Sm/Nd analysis. For the intrusive granodiorite on

#### K/AR DATA

SAMPLE	ROCK/MATERIAL	K%	40AR RAD. (X10-6 CC STP/G)	40AR ATM. %	AGE MA
AB 65-SPK7367	SCHIST/MUSCOVITE	7.4116	70.69	7.92	230±5
AB 19B-SPK7253	GNEISS/MUSCOVITE	8.0684	68.19	12.70	205±6
AB 23A-SPK 7252	GRANODIORITE/BIOTITE	4.7994	27.06	25.33	140±6

### ANALYTICAL DATA FOR ZIRCONS FROM BARILOCHE AREA- RIO NEGRO - ARGENTINA

FRACTION (1)	WEIGHT (g)	CONCENTRATION (ppm) (2)		OBSERVED (3)	ATOMIC RATIOS (4)			AGES (5)		
		U	Pb		<sup>206</sup> Pb/ <sup>204</sup> Pb	<sup>206</sup> Pb/ <sup>238</sup> U	<sup>207</sup> Pb/ <sup>235</sup> U	<sup>207</sup> Pb/ <sup>206</sup> Pb	<sup>206</sup> Pb/ <sup>238</sup> U	<sup>207</sup> Pb/ <sup>235</sup> U
<b>LAGO GUTIÉRREZ</b>										
AB23 NM(0)	0.001114	684	25.04	1796.28	0.036069	0.288967	0.058105	228	258	534
AB23 M(1)	0.000854	894	36.12	1560.55	0.039178	0.354429	0.065613	248	308	794
AB23 M(0)	0.001321	909	33.94	1204.24	0.036358	0.284535	0.056758	230	254	482
AB23 M(2)	0.00053	923	41.35	197.04	0.033967	0.261881	0.055916	215	236	449
<b>CANADON DE LA MOSCA</b>										
AB123 M(-4)	0.00089	69.58	5.25	139.35	0.051039	0.376421	0.053490	321	324	350
AB123 M(-5)	0.00096	169.99	10.82	290.15	0.059789	0.375466	0.053417	320	324	346
AB 123 M(-3)	0.00098	63.46	4.21	168.83	0.048657	0.357823	0.053336	306	311	343

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

the coast of Gutiérrez lake (SPS 102, AB23A; 41° 15' 58"S – 71° 29' 34"W) a model TDM age of  $1.206 \pm 41$  Ma. For the amphibolite from Cañadón de la Mosca (AB 123; 41° 31' 41"S – 71° 27' 30"W) the TDM age was of  $1343 \pm 82$  Ma.

#### DISCUSSION

The radiometric data represent a contribution to the thorough knowledge of the igneous-metamorphic Bariloche basement, and to the comparison with other bordering zones, such as the Mamil Choique Formation in the Limay region and

the Colohuincul Formation of the San Martín de los Andes region.

The schist and gneissic rocks of the basement exposed to the south of Bariloche could not be dated by the Rb/Sr method although a considerable number of whole rock samples had been obtained. This would be evidencing, at least for the schists and gneisses of Gutiérrez lake, opening processes of the isotopic system, calling to question the age previously obtained (Dalla Salda et al.,1991) of approximately 700 Ma.

The K/Ar ages on metamorphic rocks (230-

205 Ma; Middle-Upper Triassic), are considered cooling ages and would indicate the regional uplifting of a thickened crust that underwent metamorphic and magmatic processes during the Upper Paleozoic. The K/Ar age (Lower Cretaceous) of intrusive granodiorite on metamorphites is considered to be the youngest and would indicate the deformation and intrusive effects produced in the magmatic belt from the Andean region.

U/Pb analyses were performed for the crystallization components of the Crystalline Basement. The value obtained on the foliated amphibolite (Lower Carboniferous) would show the occurrence of significant processes of magmatism, metamorphism and deformation during the Upper Paleozoic. These processes would have ended by the Triassic, according to the K/Ar ages and the disconformity of sedimentary rocks with fossil flora from the Upper Triassic. Notwithstanding, the possibility exists that older metamorphic rocks also constitute the basement.

Sm/Nd TDM ages (Mid-Proterozoic) are in agreement with other values obtained on Patagonia and together, indicate an important Mesoproterozoic event of crust formation.

Taking into account the results reported for the basement rocks from the Limay river region by Varela et al. (this Symposium), it is possible to point out that in the Upper Paleozoic, important geodynamic processes took place in the environment of a magmatic belt in the west of the North-Patagonian region. The significant igneous-metamorphic activity would have caused considerable crustal thickening, followed in the Upper Permian to

Triassic by regional uplifting, posttectonic intrusiveness and formation of wide sedimentary basins with a volcano-sedimentary infilling.

## ACKNOWLEDGEMENTS

Field and laboratory work were performed with the support of CONICET (Argentina) – CNPq (Brazil) in the frame of an International Joint Project.

## REFERENCES

- Dalla Salda, L.H., Cingolani, C.A. & Varela, R. 1991. El basamento cristalino de la región norpatagónica de los Lagos Gutiérrez, Mascardi y Guillermo, provincia de Río Negro. *Revista de la Asociación Geológica Argentina*, 46(3-4):263-276.
- Feruglio, E. 1947. Hoja 40b, San Carlos de Bariloche. Dirección General de Minas y Geología.
- González Bonorino, F. 1944. Descripción geológica de la Hoja 41b, Río Foyel. Dirección Nacional de Geología y Minería, Boletín 56.
- González Bonorino, F. 1973. Geología del área entre San Carlos de Bariloche y Llao Llao. Fundación Bariloche, 16:1-53.
- Halpern, M., Stipanovic, P.N. & Toubes, R.O. 1975. Geocronología (Rb/Sr) en los Andes Australes Argentinos. *Revista de la Asociación Geológica Argentina*, 30(2):180-192.
- Toubes, R.O. & Spikermann, J.P. 1973. Algunas edades K/Ar y Rb/Sr de plutonitas de la Cordillera Patagónica entre los paralelos 40° y 44° de Latitud Sur. *Revista de la Asociación Geológica Argentina*, 28(4):382-396.

