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

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## 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 Guillelmo lakes, and further to the south, in the minor outcrops near Villegas river (Fig.1).

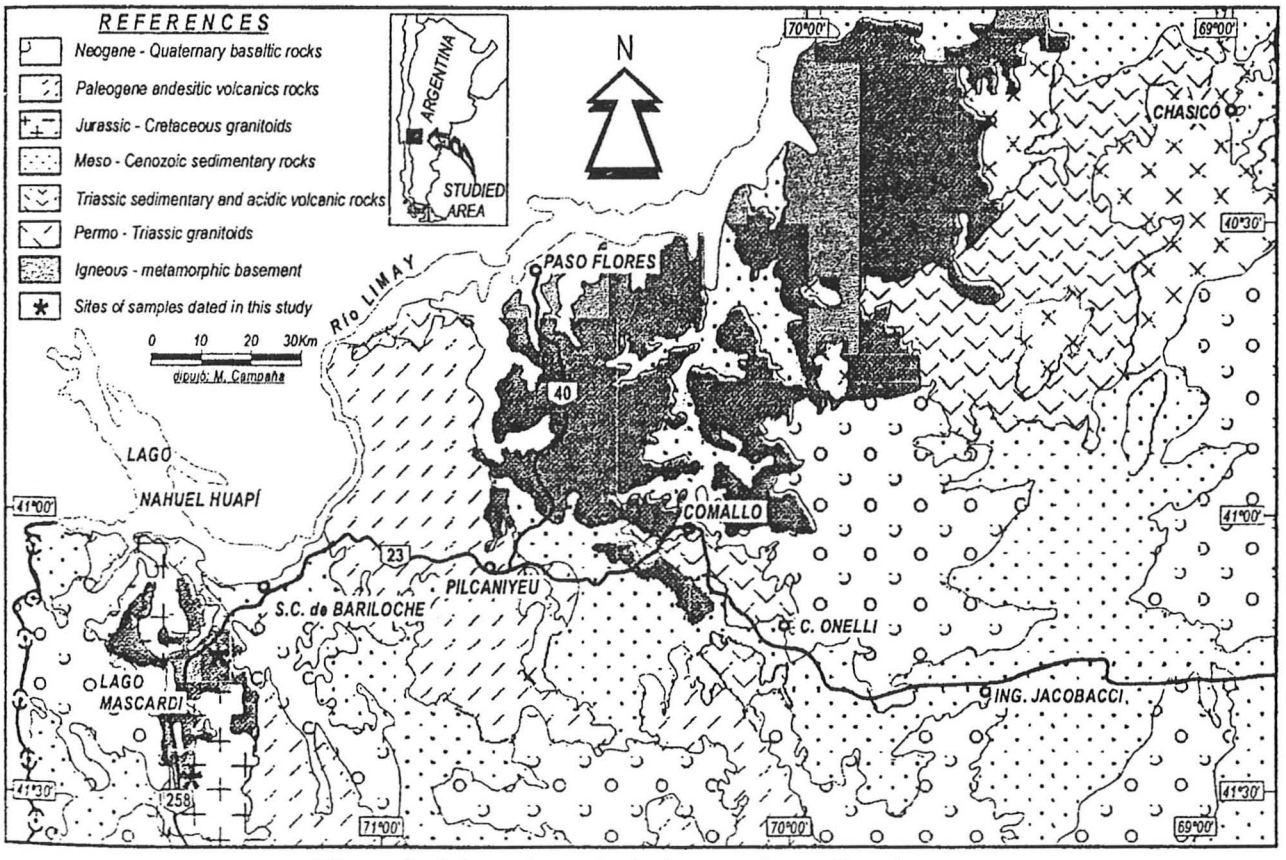


**Figure 1:** Schematic geological map and sampling sites.

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 ± 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 yieldes an age of 727 ± 48 Ma, and K/Ar ages on amphibolites were of 344 ± 30 Ma and 329 ± 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°/31°S and N130/61°NE, wich 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 bodie 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° 12' 50"S – 71° 24' 08"W), with an age value of 230 ± 5 Ma. Dating from tonalitic gneisses (SPK 7253, AB19B; 41° 13' 14"S – 71° 24' 43"W) yieldes an age of 205 ± 6 Ma. Biotite age 140 ± 6 Ma was dated from the granodioritic intrusive in the basement rocks (SPK 7252, AB23A; 41° 15' 58"S – 71° 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.

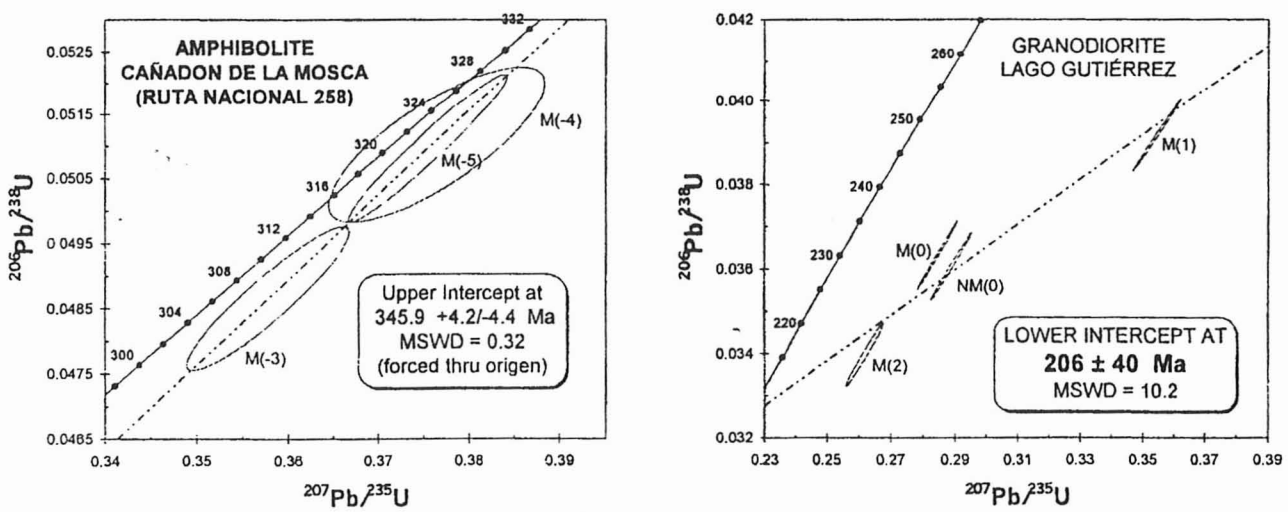


**Figure 2**: Concordia diagrams.

### 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° 31' 41"S – 71° 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 ± 40 Ma (Fig. 2 and 3).

Sm/Nd METHOD

Both U/Pb-samples were processed for Sm/Nd analysis. For the intrusive granodiorite on the coast of Gutiérrez lake (SPS 102, AB23A; 41° 15' 58"S – 71° 29' 34"W) a model TDM age of 1.206 ± 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 ± 82 Ma.

**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-
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| FRACTION (1) | WEIGHT | CONCENTRATION (ppm) (2) | | OBSERVED (3) | ATOMIC RATIOS (4) | | | AGES (5) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (g) | U | Pb | $^{206}Pb/^{204}Pb$ | $^{206}Pb/^{238}U$ | $^{207}Pb/^{235}U$ | $^{207}Pb/^{206}Pb$ | $^{206}Pb/^{238}U$ | $^{207}Pb/^{235}U$ | $^{207}Pb/^{206}Pb$ |
| LAGO GUTIÉRREZ | | | | | | | | | | |
| 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 |
| | | | | | | | | | | |
| CANADON DE LA MOSCA | | | | | | | | | | |
| 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

## 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, postectonic intrusiveness and formation of wide sedimentary basins with volcano-sedimentary infilling.

## ACKNOWLEDGEMENTS

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