GEOLOGICAL AND GEOCHEMICAL SETTING OF THE MAZAN GRANITE CONTAINING ANDALUSITE-PEGMATITES, ARGENTINA

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INTRODUCTION

The Mazán pegmatitic field integrates the Pampean Pegmatitic Province. It is located at northeastern of the La Rioja province, Northwestern Argentina. The pegmatites from Mazán field have spatial relationship with Mazán Granite –MG- defined by Fogliata and Avila (1997). We found magmatic andalusites from pegmatites in MG, but they are not found in other pegmatites in Argentina so far.

The main goal of this paper is to characterize MG and its andalusite-bearing pegmatites associated inside of geological and geochemical setting.

GEOLOGICAL SETTING AND PETROGRAPHY OF PEGMATITES

Some granitic masses occur in the Mazán range, but the MG is the most important (figure 1). The MG has been dated at 484.2 ±3.1 Ma using U-Pb SHRIMP (Pankhurst et al., 2000). The metasedimentary rocks named La Cébila Formation (González Bonorino, 1951) constitute the host-rocks of the MG occurring as roof pendant whose age is Upper Precambric - Lower Paleozoic.

The MG is intruded by the La Quebrada Granite (Fogliata and Avila, 1997). It is characterized by a banded structure of alternating tourmaline and muscovite bearing pegmatites and aplites and biotite-bearing medium to coarse equigranular granite. In some cases, these bands are folded and wedged out. The La Quebrada Granite is located in the center-eastern and northern sectors of the Mazán range and in the La Angostura area (Fig. 1).

Cataclastic and mylonitic rocks can be found in the center-south of the MG. Moreover, a small stock of undeformed granite (UG) with porfiroid texture is located in the southwestern margin of MG (figure 1). The relationship between the UG and the MG has not been observed in the field so far, but the UG could be younger than MG probably intruding it.

The MG has porfiroid texture with idiomorphic megacrysts of perthitic microcline in an equigranular matrix which

is composed by feldspars, quartz, biotite, muscovite and cordierite. Schalamuk et al. (1989) recognize besides, andalusite, garnet and apatite. Sometimes, it is possible to observe tourmaline in the MG. Cordierite shows discrete and euhedral to subhedral grains. On the other hand, the MG contains rounded and lengthen enclaves up to 30 cm. The lithology of the enclaves consists in metapelites and metapsamites where can be observed relict sedimentary structures.

The MG contains several quartz vein and small pegmatite dykes and thickness veins. Moreover, the MG contains pegmatites which can reach ten meters length and have lengthened and ellipsoidal shape. They usually include a border of aplite (BA). Quartz-core zone, intermediate zone composed of K-feldspar, quartz, muscovite and scarce biotite, and marginal zone composed of quartz, graphic microcline, micas, tourmaline and garnet are recognized by Schalamuk and Ramis (1999). Andalusite and ilmenite can appear into the intermediate zone. Recently, corundum associated to andalusite has been identified using XRD study (Sardi et al., 2009).

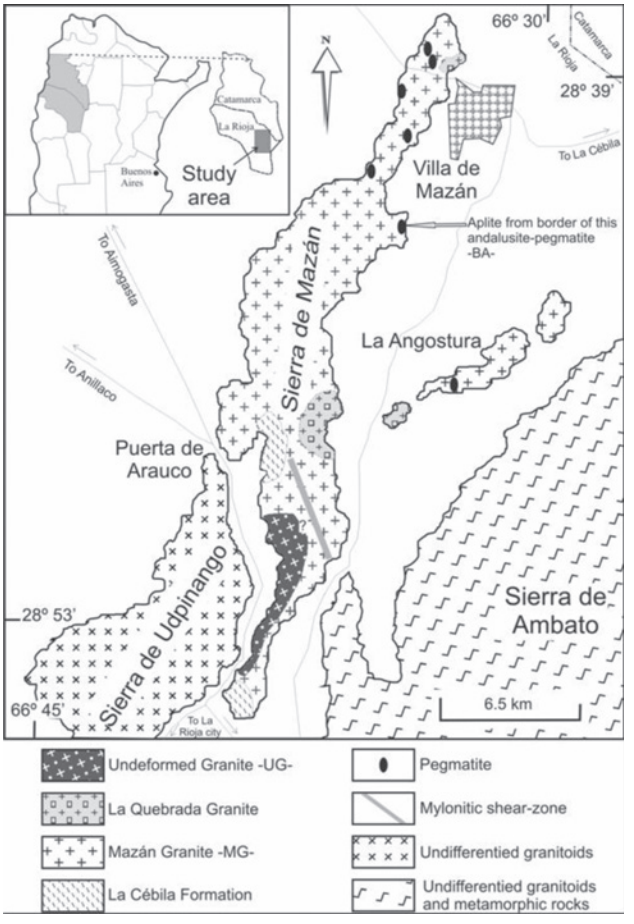

Figure 1.- Geology of the Mazán Pegmatitic Field.

GEOCHEMISTRY

The chemical analysis was carried out on MG (*n* = 4), UG (*n* = 1) and BA (*n* = 1). The majority elements were analyzed in the Geochemistry lab from Naruto University of Education (Japan) using XRF methodology. While the trace elements were analyzed in the Geological Survey of Spain (IGME, Madrid) using the same methodology except for REE that were analyzed by ICP-MS methodology. The results are shown in table 1.

The main geochemical feature of MG is the highly peraluminous character. It has values molar ratio Al_2O_3/($CaO+Na_2O+K_2O$) (ASI) between 1,47 and 1,67 and average 1,52 (figure 2A). The accessory minerals ponder the high aluminosity values. The peraluminous feature had been studied in previous works such as Schalamuk et al. (1989) and Toselli et al. (1991) which obtained an ASI always > 1. Besides, the plot for MG into the aluminosity diagram of the figure 2A show a continuous independent tend and far to the UG (ASI = 1,08) and BA (ASI = 1,14). The presence of the pegmatites containing muscovite, andalusite and corundum complete the peraluminous geochemical environment of the Mazán range.

Table 1 - Representative bulk chemical compositions of MG, UG and BA. Major elements in % wt; Trace elements in ppm.

	MG				UG	BA	REE	MG				UG	BA
	7881	7883	7885	7886	7876	7879		7881	7883	7885	7886	7876	7879
SiO_2	68,3	68,51	68,12	68,58	72,12	81,55	La	30,3	36,9	34,6	34,2	30,1	10,3
TiO_2	0,61	0,61	0,61	0,66	0,32	0,15	Ce	69,1	77,6	73	71,8	63,8	25,6
Al_2O_3	14,75	14,44	14,57	14,58	13,8	10,03	Pr	7,63	9,12	8,48	8,55	7,33	3,31
FeO^T	3,76	4,03	4,05	4,28	1,83	0,95	Nd	29,3	34,9	32,5	32,3	27,4	12,3
MgO	1,43	1,50	1,45	1,65	0,49	0,32	Sm	6,39	7,24	6,64	6,79	5,22	3,6
MnO	0,07	0,06	0,06	0,07	0,07	0,02	Eu	1,07	1,21	1,18	1,04	0,65	0,28
CaO	0,92	0,9	1,04	0,65	1,13	0,49	Gd	6,24	7,05	6,47	6,83	4,50	3,46
Na_2O	2,21	2,13	2,24	2,3	3,51	3,94	Tb	1,00	1,11	0,96	1,07	0,62	0,69
K_2O	4,38	4,14	4,13	3,48	4,6	1,34	Dy	6,08	6,48	5,67	6,45	3,3	4,26
P_2O_5	0,29	0,17	0,17	0,17	0,23	0,17	Ho	1,19	1,28	1,11	1,30	0,62	0,71
ASI	1,47	1,50	1,45	1,67	1,08	1,14	Er	3,53	3,8	3,28	3,96	1,78	2,06
Rb	244,2	188	184,2	155	395,1	82,2	Tm	0,49	0,55	0,47	0,58	0,26	0,35
Y	32,3	34,6	29,6	35	17,1	21,1	Yb	3,21	3,58	3,04	3,71	1,79	2,68
Nb	17,1	15,6	15,9	17,1	24,0	5,7	Lu	0,50	0,53	0,46	0,55	0,25	0,38
K/Rb	149	183	186	186	97	135							

The analyzed samples of the MG are characterized by the very restricted SiO_2 content (= 68%). For this reason, the evolving tend of the elements during the fractionated crystallization is better observed using the relation K/Rb than % SiO_2. The K/Rb relationship varies between 150 and 200 for the MG and it is slightly less than 100 for the UG (figure 2B).

The REE chondrite-normalized diagram for all samples (MG, UG and BA) shows a light gradient and parallel pattern (figure 2C). The normalized average La/Yb_{MG} is 6,74. The Eu-anomaly is very marked -$Eu/Eu^*_{\text{all plotted samples}} > 1$-. The lanthanide tetrad effect is notable in BA being $T_{1,3\ -\ BA} = 1.169$ according nomenclature of Irbie (1999).

REMARKABLE CONSIDERATIONS

The metasedimentary host rocks and their enclaves present into the magma, presence of cordierite in the granite and andalusite in the associated pegmatites are valid geological features to allow inferring a supracortical placed for MG. The geochemical feature more notable for MG is the highly peraluminous character. According to the mineralogical, petrographical and geochemical characteristics, the MG could be considered a typical S-type pegmatite-generating granite from Pampean Pegmatitic Province, although isotopic data is not available yet.

It may be attributed to metasedimentary clastic packages belong to the La Cébila Formation, rich in alumina, as the main crustal component generating of the magmatism from which the MG is formed.

The tourmaline mainly, and other minerals such as muscovite, are indirect indicators of richness in volatile of the granite-pegmatite system. Rossi et al. (1985) suggested that the high aluminous content in several granites from Pampean Ranges Province can have been acquired through the concentration of volatile in the magma which makes an important thermal decrease in the liquidus favoring the formation of the alumina bearing minerals.

As mineralogical, petrographical and geochemical factors as well as field observations establish that the MG would have not co-magmatic relationship with UG, further geologic studies, essentially geochronological nature, allow confirming such asseveration.

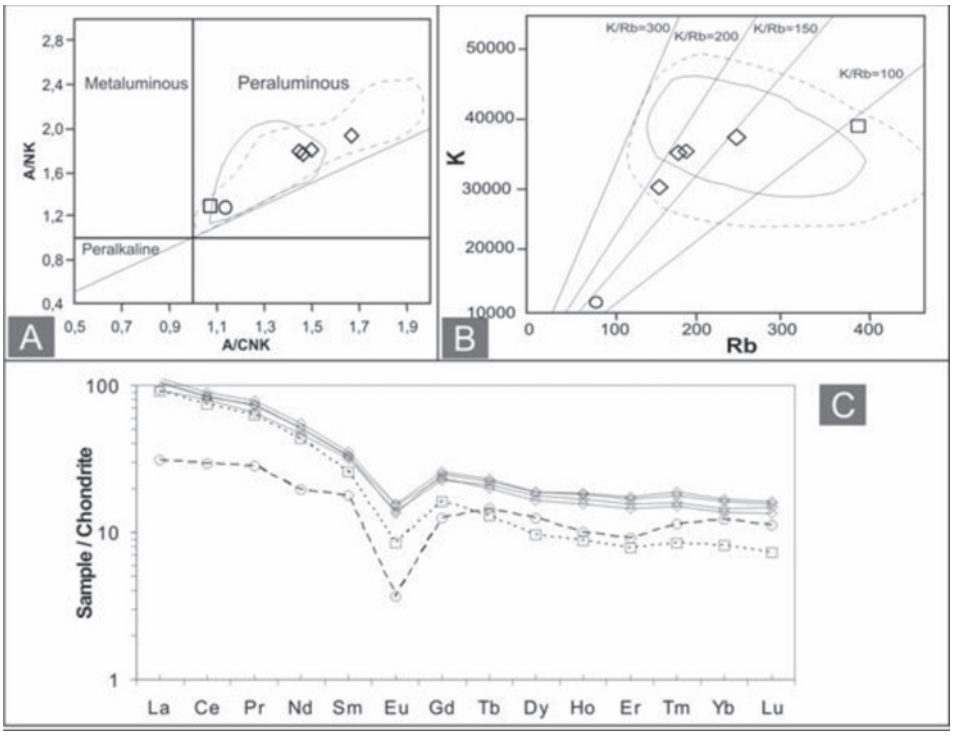

Figure 2.- Geochemical diagrams. A.- Aluminosity of Maniar & Piccolli (1989); B.- K-Rb; C.- REE-Normalized diagram. In figures A and B, solid line is MG-plot according to Schalamuk et al. (1989) and dotted line are Granitic rocks from Mazán range according to Toselli et al. (1991). References: open diamond, MG; open square, UG; open circle, BA.

REFERENCES

Fogliata, A. & Avila, J. 1997. Manifestaciones minerales de la ladera occidental del Cerro Mazán, provincia de La Rioja, Argentina. *VIII Congreso Geológico Argentina*, 2:961-965.

González Bonorino, F. 1951. Una nueva formación Precámbrica en el noroeste Argentino. Comunicaciones Científicas. *Museo de La Plata*, Nº 5.

Irber, W. 1999. The lanthanide tetrad effect and its correlation with K/Rb, Eu/Eu*, Sr/Eu, Y/Ho, and Zr/Hf of evolving peraluminous granite suites. *Geochimical et Cosmochimical Acta*, 63:489–508.

Maniar, P. & Piccoli, P. 1989. Tectonic discrimination of granitoids. *Geological Society American*, 101:635–643.

Pankhurst, R. J., Rapela, C., Fanning, C. (2000): Age and origin of coeval TTG, I- and S- type granites in the Famatinian belt of NW Argentina. *Transactions of the Royal Society of Edinburgh: Earth Sciences*, 91:151-168.

Rossi de Toselli, J., Toselli, A., Indri, D., Saavedra, J., Pellitero, E. 1985. Petrología y geoquímica de plutones fuertemente peraluminicos de las Sierras Pampeanas: el problema de los granitos cordieríticos. *Asociación Argentina de Mineralogía, Petrología y Sedimientología*, Revista 16:55-64

Sardi, F., Bengochea, L., Mas, G. 2009. The mineral assemblage andalusite-corundum in "La Aurora" pegmatite from Mazán pegmatitic field, northwestern Argentina. *This volume*.

Schalamuk, I. & Ramis, A. 1999. Pegmatitas andalucíticas de Mazán, La Rioja. In: Zappettini, E. (Ed.). Recursos Minerales de la República Argentina. SEGEMAR, Anales 35:397-400.

Schalamuk, I., Toselli, A., Saavedra, J., Echeveste, H., Fernández, R. 1989. Geología y mineralización del sector este de la sierra de Mazán, La Rioja, Argentina. *Asociación de Mineralogía y Petrología*, Revista 20 (1-4): 1-12.

Toselli, G., Saavedra, J., Córdoba, G., Medina, M. 1991. Petrología y geoquímica de los granitos dela zona Carrizal-Mazán, La Rioja y Catamarca. *Asociación Geológica Argentina, Revista*, XLVI (1-2): 36-50.