

## **EDADES Ar-Ar, K-Ar Y RAZONES ISOTOPICAS DE Sr DE LAS ROCAS ANDESÍTICAS MIOCENAS, DE LA FRANJA MARICUNGA Y LAS POSIBLES FUENTES MAGMATICAS**

### **K-Ar AND $^{40}\text{Ar}/^{39}\text{Ar}$ AGE AND Sr ISOTOPIC COMPOSITION OF MIOCENE ANDESITIC ROCKS OF THE MARICUNGA BELT AND THEIR POSSIBLE MAGMA SOURCES**

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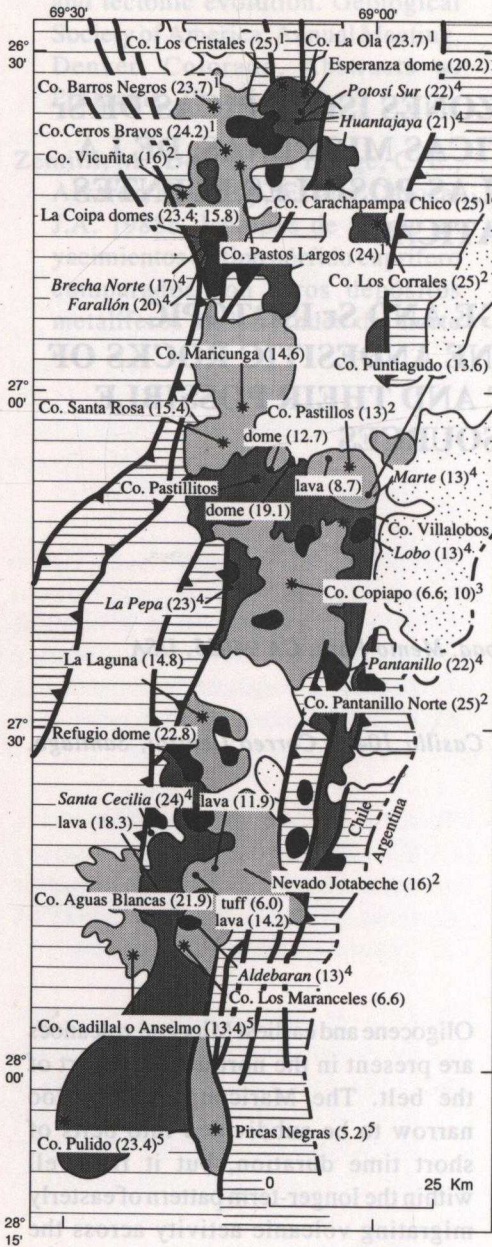
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Volcanic rocks in the 150 by 30 km north-trending Maricunga belt range in age from latest Oligocene through Miocene based on 19 new K-Ar, 5 new  $^{40}\text{Ar}/^{39}\text{Ar}$ , and 15 published K-Ar and  $^{40}\text{Ar}/^{39}\text{Ar}$  age determinations (table 1 and fig. 1). The oldest rocks dated are about 25 Ma, and the youngest are about 6 Ma. There appears to be no time-spatial patterns of volcanism in the Maricunga belt either by longitude or latitude; volcanic rocks of both the oldest and youngest ages are found together, although only latest

Oligocene and earliest Miocene volcanoes are present in the northernmost part of the belt. The Maricunga belt is too narrow to be subdivided into belts of short time duration, but it fits well within the longer-term pattern of easterly migrating volcanic activity across the Andes. Magma was generated in the region for about 19 million years before the locus of volcanism migrated eastward to the present crest of the Andes where volcanoes are active today.





**EXPLANATION**

- Alluvium (Quaternary)
- Volcanic rocks (Pliocene)
- Volcanic rocks (late and middle Miocene)  
Dark area indicates alunite alteration
- Volcanic rocks (early Miocene)  
Dark area indicates alunite alteration
- Volcanic and sedimentary rocks (Mesozoic)
- Volcanic and sedimentary rocks (Paleozoic)
- Volcanic vent
- Dated sample site
- Italics* Alunite or sericite alteration
- (14.6)<sup>3</sup> Radiometric age in Ma; superscript gives data source listed in figure caption

Figure 1 Geologic map of the Maricunga volcanic belt (modified from Davidson and Mpodozis, 1991). Names of volcanic centers are in block print, areas of alteration are in italics. The radiometric age of unaltered rock and alteration is in parenthesis. Sources of data: 1. Moscoso et al., (1993), 2. Davidson and Mpodozis, (1991), 3. Walker et al., (1991), 4. Sillitoe et al., (1991), 5. Kay et al., (1991), 6. Baker et al., (1987).



Most of the rocks erupted over the 19-million-year span of volcanic activity in the Maricunga belt are calcic andesites and dacites with 60 to 64% SiO<sub>2</sub> (normalized anhydrous). They are porphyritic with phenocrysts of plagioclase and hornblende, and some have pyroxene. Major and trace element contents show limited and gradational ranges, but strontium isotopic compositions define two distinct groups; a western group with initial <sup>87</sup>Sr/<sup>86</sup>Sr (Sr<sub>i</sub>) values between about 0.7048 and 0.7051 and an eastern group with Sr<sub>i</sub> between about 0.7058 and 0.7061 (fig 2). The two groups have no correlation with the age of the rock; rocks in the higher Sr<sub>i</sub> group range in age between about 20 Ma to 9 Ma and those in the lower Sr<sub>i</sub> group between about 18 Ma and 12 Ma.

When the Maricunga belt samples (18 total including five from Kay et al. 1991 and one from Walker, et al., 1991, two from Baker et al., 1987) are plotted on a <sup>87</sup>Sr/<sup>86</sup>Sr versus <sup>87</sup>Rb/<sup>86</sup>Sr diagram (fig. 3), the two Sr<sub>i</sub> groups are readily apparent as coherent data fields. Limiting lines (LL<sub>1</sub> and LL<sub>2</sub> on fig. 3), defined by the minimum <sup>87</sup>Rb/<sup>86</sup>Sr per <sup>87</sup>Sr/<sup>86</sup>Sr values of each of the higher and lower Sr<sub>i</sub> data fields, approximate the parent magmas derived from two time-integrated Rb-Sr sources. These limiting lines are not isochrons.

The two groups of generally similar rocks with different Sr<sub>i</sub> are interpreted to be generated from two compositionally similar lower crustal magma sources of different age and Sr<sub>i</sub>. The overall similarity of major and trace elements indicates that the two magmas formed by like degrees of partial melting of similar lower crust with subsequent like degrees of fractional crystallization. It seems unlikely that exactly the right amounts of contamination by variable upper crustal

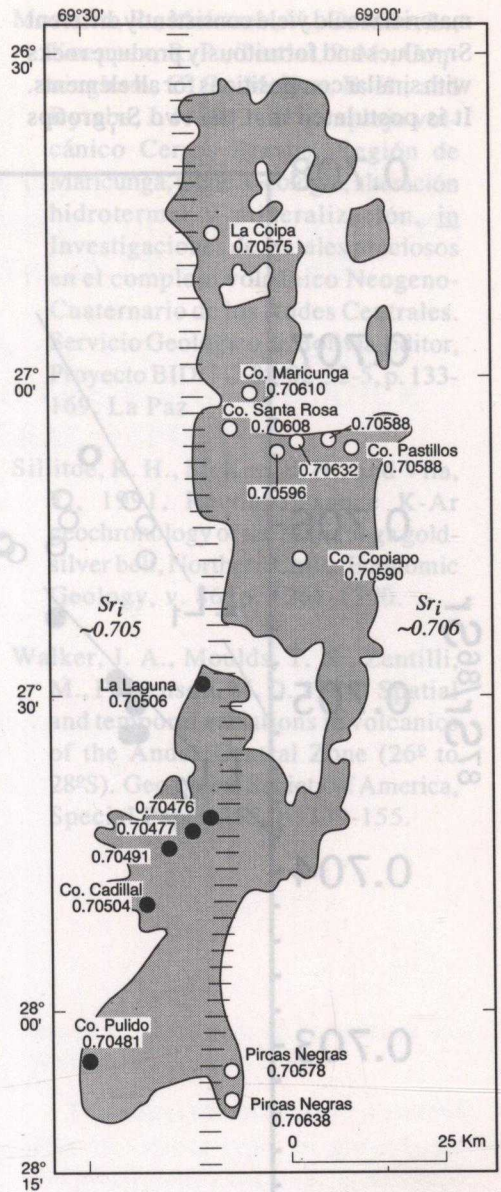


Figure 2: Map of the Maricunga volcanic belt showing locations of samples with measured <sup>87</sup>Sr/<sup>86</sup>Sr and initial <sup>87</sup>Sr/<sup>86</sup>Sr (Sr<sub>i</sub>). The Sr<sub>i</sub> values group near 0.7050 (filled circles) and 0.7060 (unfilled circles). The groups can be separated by a N-S boundary shown by horizontal hachures. The gray area is late Oligocene and Miocene volcanic rocks, modified from Davidson and Mpodozis (1991). The Sr<sub>i</sub> value for Co. Pastillos is from Baker et al., (1987); for Co. Copiapo from Walker et al., (1991); and the Sr<sub>i</sub> values for Co. Pulido and Pircas Negras are from Kay et al., (1991).



material would yield consistently different  $Sr_i$  values and fortuitously produce rocks with similar compositions for all elements. It is postulated that the two  $Sr_i$  groups

reflect two adjoining lower crustal magma sources belonging to a collage of differentiating age crust on the western edge of the South American craton.

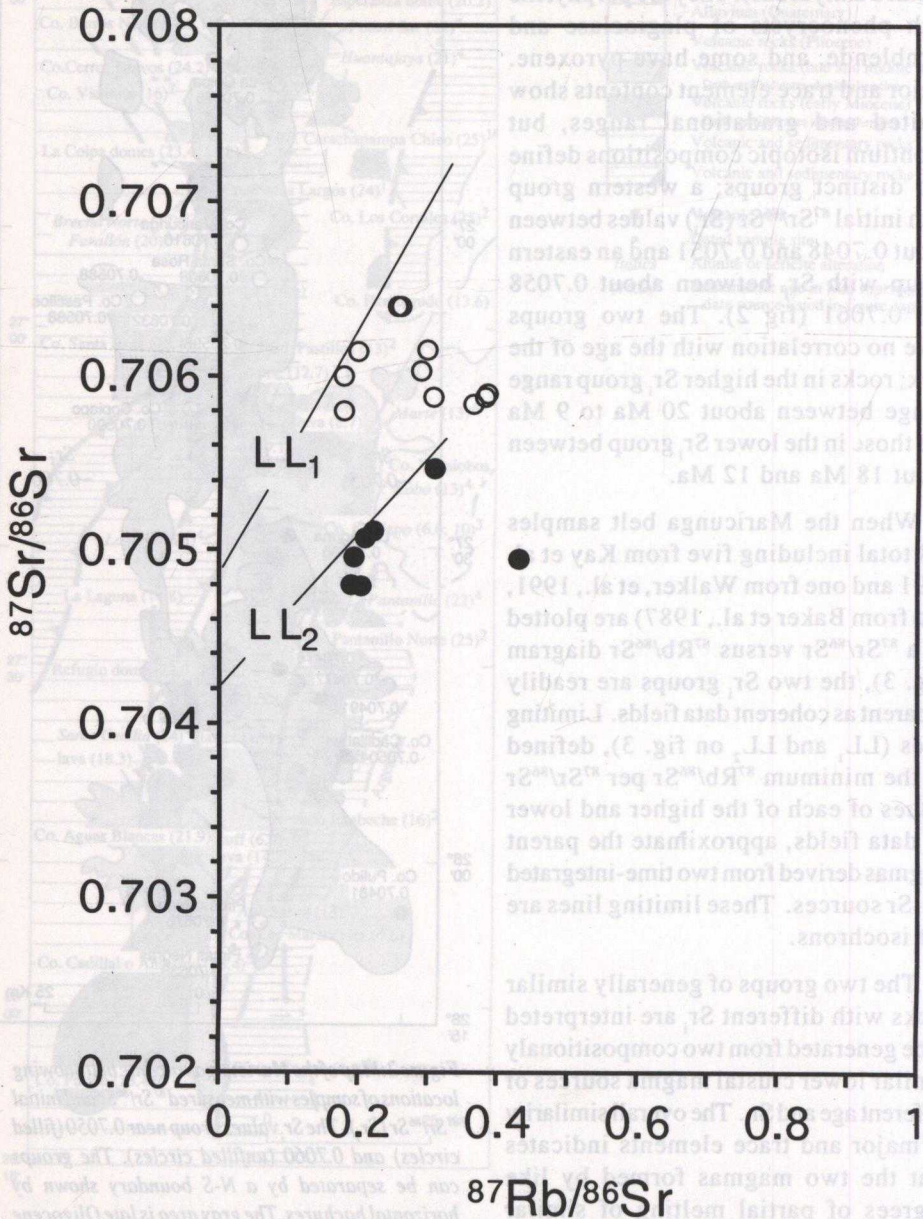


Figure 3 Measured  $^{87}Sr/^{86}Sr$  versus  $^{87}Rb/^{86}Sr$  diagram for late Tertiary volcanic rocks in the Maricunga belt. Limiting lines (LL), defined by the minimum  $^{87}Rb/^{86}Sr$  per  $^{87}Sr/^{86}Sr$  values of each of the higher and lower  $Sr_i$  data fields, constrain the isotopic composition of parent magmas derived from two time-integrated Rb-Sr sources. Sources of data: this paper; Baker et al., (1987); Kay et al., (1991); and Walker et al., (1991).



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## INTRODUCTION

Quantitative isotopic tracing of meteoric water in hydrothermal ore deposits has provided much information on water/rock interaction related to wallrock alteration, metal transport and deposition (e.g., H. P. Taylor, 1974). The identification of isotopically unaltered or only slightly altered surface waters in hydrothermal deposits can also potentially provide constraints on the heat and material balance that characterizes mixing processes which lead to alteration and mineral precipitation. Further isotopic recognition of paleo-surface waters can assist in paleo-hydrologic reconstruction and provide information on climatic and

tectonic evolution (e.g., Alpers and Whittimore, 1990).

This paper summarizes new isotopic data on various types of groundwater and precipitation in Chile, plus isotopic data from the literature (largely from IAEA-supported studies) in the form of a preliminary  $\delta^{18}\text{O}$  and  $\delta\text{D}$  contour maps of South America. The topology of these maps differs markedly from that published by Yumsev (1975; Figure 1). The purpose of constructing these maps is to provide a graphical reference point for the recognition of meteoric waters in young hydrothermal ore deposits. Similar isotopic

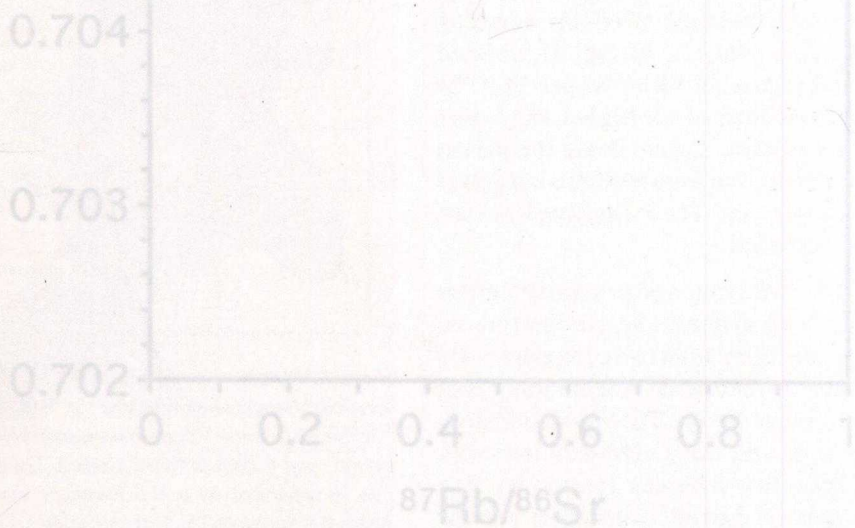


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