

UNSPIKE K-Ar DATINGS FOR THE BACKARC VOLCANISM OF THE SOMUNCURA PROVINCE AND ADJACENT AREAS, RÍO NEGRO, ARGENTINA *

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INTRODUCTION

Conventional method of K-Ar dating is performed with help of the ³⁸Ar “spike”, also called “tracer”, in order to obtain absolute amount of ⁴⁰Ar, namely isotopic dilution method. This method is convenient in the laboratory technical operations and is able to date the igneous rock of a wide age range, from 1 Ma up to more than 4,550 Ma, with enough analytical precision for most of the geologic interpretations. In addition, various types of igneous rocks, with exception of some ultramafic rocks, e.g. granites, syenites, diorites, and basalts can be dated. Because of well-established laboratorial processes and wide applicability, the isotopic dilution K-Ar method is adopted by many geochronological laboratories of the world as a classic dating technique.

However, this method is unable to date Quaternary volcanic rocks, younger than 1 Ma, because of extremely low content of radiogenic ⁴⁰Ar. For such young volcanic rocks, the sensibility method of K-Ar without spike application, so-called unspike method, is useful. In case of basaltic lavas, this method can date very young samples, up to 10 Ka (0.01 Ma). However, the samples older than 100 Ma cannot be analyzed because of the excess Ar content for the analytical line.

This short paper reports the results of first application of the unspike K-Ar datings of South American basaltic rock samples, of the Somuncura province and adjacent areas, located to the east of the Andes Arc.

ANALYTICAL METHODOLOGY

Instead of the long history of the isotopic dilution K-Ar dating, the unspike method was developed relatively in recently years (e.g. Gillot et al. 1982; Nagao et al. 1991; 1996). This method requires the gas mass spectrometry line of ultra-high precision and the determination of exact amount of the specimen to be injected to the Ar extraction compartment. Because of the technically delicate laboratorial procedures that requires the well-trained staff of high skill, only few laboratories of the world can perform the unspike K-Ar dating. The datings of this report are the first analyses of

South American rock samples submitted to the unspike method.

The analytical procedures were different from those of conventional isotopic dilution method and they were accomplished at the University of Tokyo, Japan. The main laboratory works were performed using high sensibility gas spectrometry system for Ar isotopes installed at the Laboratory of Earthquake Chemistry and the XRF chemical analyses apparatus of the Earthquake Research Institute for K quantification.

The rock samples were cut in cubes, of 1.5 x 1.5 x 2.5 cm, and the cubes were crushed into grains and sieved in a range of 30 to 40 (#60 to #80) µm in size. The grains of about 50 mg are coated by thin aluminum foil, of about 20 µm. The exact wait of the foil and rock grains are measured. The specimens are put into the waiting compartment and are sent to melting compartment. By means of melting, entire amount of argon is extracted for the isotopic analysis. In this way, the ⁴⁰Ar content is measured without spike application. The other isotopic procedures are the same of isotopic dilution method. The K content of the samples is measured at Earthquake Research Institute using X-ray fluorescence analyzer by means of 10 x dilution bead method.

REGIONAL GEOLOGY

The Somuncura basaltic plateau, called locally “Meseta de Somún Curá”, is located to the east of the Andes, 40.5-43.5°S, 71-66°W, which corresponds to northeast part of Argentine Patagonia (Fig. 1). This area is far from the Chile-Peru Trench and related orogenic zone, with more than 400 km of distance. Because of the distance more than normal backarc volcanic zones, this occurrence is called Extra-Andes volcanism (Ramos et al. 1982; Remesal et al. 2002).

The Somuncura basaltic province and adjacent areas compose the largest Patagonian volcanism. The distribution area of the lavas, about 25.000 km² (Remesal 1988), corresponds to about 10% of normal continental flood basalts (CBF). Kay et al. (1992; 1993) proposed plume origin for this occurrence, calling “baby-hotspot”.

The Somuncura plateau stands out about 700 m high from the regional surface level. The lavas of the first Oligocene eruptions are found in western part of the Somuncura plateau. There, an older basaltic lava flow occurs intercalated by regional sedimentary formation and newer one, covering the sedimentary rocks. The plateau top is covered mainly by accumulated Oligocene basaltic lavas, namely main stage plateau lavas. They are constituted by lava flows of about 7 layers with total thickness of 50 m (e.g. Remesal et al. 1999; Ardolino & Franchi, 1996; Franchi et al. 1999; Orihashi et al. 2004; Motoki et al. 2004), and are underlain by Eocene sedimentary formation. The main stage lavas are partially covered newer lavas, of the Miocene to Pliocene, normally less than 10 m thick, called post plateau lavas, and related monogenic pyroclastic cones. The volcanism of this stage extends westward from the Somuncura plateau up to the backarc area. Some of them show morphologic characteristics suggestive to be of young volcanism, such as of the Quaternary.

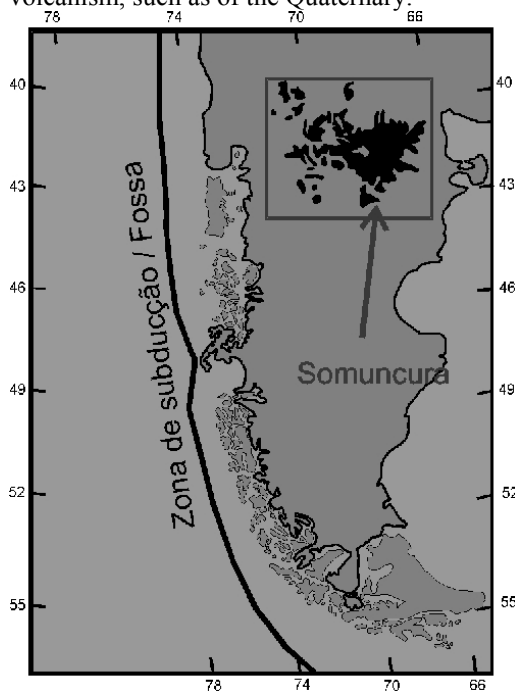


Fig. 1. Location map of the Meseta de Somuncura and adjacent basaltic volcanisms in the backarc and Extra-Andean regions, Province of Río Negro and Chubut, northern Argentine Patagonia.

RESULTS AND DISCUSSION

The present unspike K-Ar data classify the volcanic activities of the Somuncura plateau and adjacent areas into three age groups. The first stage is of 36-20 Ma, corresponding to main stage plateau lavas of the Somuncura, 66 to 70°W. The second stage is of 18-10 Ma, post plateau lavas, pyroclastic cones, and domes on the Somuncura plateau and surrounding areas, 68 to 71°W. The third stage is of 5.6-0.34 Ma, the youngest of

the areas the west and northwest of the Somuncura plateau, 69 to 71°W, extending to the backarc area (Fig. 2).

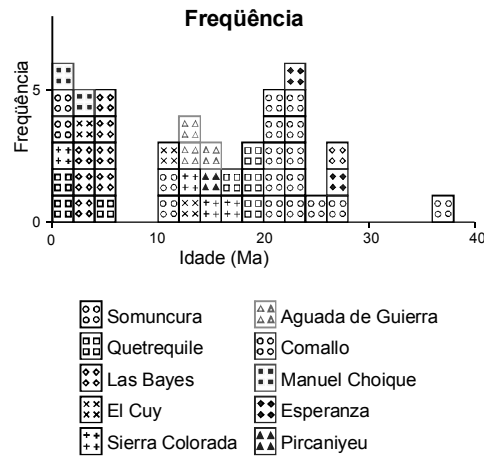


Fig. 2. Age histogram of the unspike K-Ar datings for the Somuncura volcanic province and adjacent areas.

A typical cross section of the lava flows is exposed on the lateral wall of the sinkhole pit, called Laguna Azul, present at central part of the Somuncura plateau). This section shows five accumulated lavas of total thickness of 30 m. The unspike K-Ar ages of four lower lavas are of the Oligocene, being 22-23 Ma, that is of the first stage. Therefore, the main stage plateau lavas were formed in a period relatively short. The top lava is of the Miocene, 10.7 Ma, corresponding to the second stage. The largest eruptions of the second stage occurred in Sierra de Chauchaiñeu, 69-68°W and the largest of the third stage, Meseta Chenqueniyeu, 71-70°W. The third stage includes Quaternary volcanism.

CONCLUSIONS

The unspike K-Ar datings for the Somuncura plateau and adjacent areas show the following eruptive history (Fig. 7). The volcanism started from the Oligocene lava (36 Ma) of western part (70°W) of the Somuncura plateau. The magmatism shifted to the east and main stage plateau volcanism took place on Somuncura plateau (21-22 Ma) in a short period, namely first stage. Later, in the second stage volcanism, the post plateau magmatism of minor scale occurs on Somuncura plateau (70-68°W), forming top lavas and pyroclastic cones. The eruption center shifted to the west to Sierra de Chauchaiñeu area. The third stage volcanism took place on the areas to the west (71-70°), such as Comallo area, of still minor scale.

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RESUMO

A meseta de Somuncura, localizada a nordeste da Patagônia Argentina, corresponde a um platô de basalto com área superior a 20.000 Km² em uma região classificada como extra-retroarco. Estudos anteriores sugerem dois modelos para o magmatismo para esta região de extra-retroarco; 1) soerguimento de um pequeno *hot spot* ou 2) soerguimento do manto astenosférico resultado da rotação da placa Fallaron ou pela subducção da cadeia meso-oceânica gerando uma "janela" na placa em subducção. Neste estudo foram determinados a concentração de elementos maiores, menores e ETR além de datações em amostras de basalto coletadas na porção nordeste do platô de Somuncura e regiões adjacentes (Cerro Colorado, Quetlequile, Las Bayes, etc.) para esclarecer a evolução espaço-temporal do magmatismo da região. As idades de K-Ar indicam que as erupções dos basaltos de Somuncura iniciaram no Oligoceno (34 Ma), atingiram seu auge entre 22 e 23 Ma e minimizaram suas atividades no Mioceno médio (18-11 Ma). Entretanto nas regiões adjacentes a Somuncura existem lavas com idades do Pleistoceno (5.6-0.34 Ma). As variações da concentração dos elementos maiores, obtidos nas análises de rocha total indicam uma fusão parcial de um peridotido hidratado com diferentes graus de fusão parcial. O aumento de alcalinidade e a variação da concentração de elementos incompatíveis (K, Rb, Ba and Pb) mudam com o tempo o que pode ser atribuído a múltiplos soerguimentos do manto astenosférico enriquecido com fluidos ou aos diferentes graus de contaminação pelo manto litosférico a cada evento vulcânico.