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A Rb-Sr isochron diagram for the Znosko Glacier Formation (Cardozo Cove Group), Admiralty Bay, King George Island, Antarctica

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ABSTRACT

This paper presents and discusses the time value of 60 ± 5 Ma obtained for Znosko Glacier Formation (Cardozo Cove Group), which crops out at Admiralty Bay, King George Island. Tha data allow to design a Rb-Sr isochronic diagram after the isotopic analysis on six basaltic andesite samples from the outcrops of the Mackellar and Ezcurra inlets.

Such a result is correlated to the 57 Ma age already available for this information, obtained through the whole-rock K-Ar method, being consistent with other K-Ar data from overlaying or intruding units.

Metasomatism evidences (chloritization and carbonatization) and important structural deformations distributed in the Cardozo Cove Group, made possible to interpret as minimal the K-Ar ages of this unit, resulting from Ar partial losses by the rocks overheating in magmatic episodes, after their origin. This is added to the occurrence of fossil plants remains in the upper unit of Cardozo Cove Group (Admiralen Peak formation), considered as Upper Mesozoic, confirming the older age hypothesis for the rock unit.

The time location of Znosko Formation at late Mesozoic is neither corroborated by the obtained Rb-Sr result, but the possibility that such a value also follows from Sr isotopic homogeneity due to overlaying geological episodes is not ejected.

Key words: Geochronology, basaltic andesites, metasomatism, Upper Mesozoic.

Diagrama de isocronas Rb-Sr para la Formación Glaciar Znosko (Grupo Caleta Cardozo), bahía Almirantazgo, isla Rey Jorge, Antártica

K. Kawashita[1] y E. Soliani, Jr.[2]

RESUMEN

Este trabajo presenta y discute el valor temporal de 60 ± 5 Ma obtenido para la Formación Znosko Glaciar (Grupo Cardozo Cove) que aflora en el interior de la bahía Almirantazgo, isla Rey Jorge. Los datos permiten la elaboración de un diagrama isocrónico Rb-Sr a partir del análisis isotópico de 6 muestras de andesitas basálticas, provenientes de los afloramientos de las ensenadas Mackellar y Ezcurra.

Tal resultado es comparable con la edad de 57 Ma ya disponibles para la formación, obtenida por el método K-Ar en roca-total, y es coherente con otros datos K-Ar provenientes de unidades que la cubren o intruyen.

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Evidencias de metasomatismo (cloritización y carbonatización) y de deformaciones estructurales importantes repartidas en el Grupo Cardozo Cove, hicieron que las edades K-Ar de esta unidad fuesen interpretadas como mínimas, resultantes de pérdidas parciales de Ar por el recalentamiento de las rocas en episodios magmáticos, posterior a su origen. Esto se suma a la ocurrencia de restos de plantas fósiles en la unidad superior del Grupo Cardozo Cove (Formation Admiralen Peak) considerados como el Mesozoico Superior, corroborando la hipótesis de una antigüedad mayor para el conjunto rocoso.

La posición temporal de la Formación Znosko Glaciar, al final del Mesozoico, tampoco es confirmada por el resultado Rb-Sr obtenido, pero no se excluye la posibilidad de que este valor también resulte de homogenización isotópica del Sr como consecuencia de episodios geológicos superpuestos.

Palabras claves: Geocronología, andesitas basálticas, metasomatismo, Mesozoico Superior.

INTRODUCTION

This paper presents and discusses a new Rb-Sr isochron diagram including six whole-rock isotopic analysis of lavas from the Znosko Glacier Formation (Cardozo Cove Group), Inner Admiralty Bay, King George Island, South Shetland Islands, Antarctica (Fig. 1 and 2).

The samples are andesites collected during the Second Brazilian Antarctic Expedition, in 1984, and dated radiometrically at the Geochronological Research Center of the Institute of Geosciences, University of São Paulo, Brazil.

The new Rb-Sr isochron age is concordant with a previous K-Ar age presented by Birkenmajer *et al.* (1983a) and also with other K-Ar ages from younger lithostratigraphic units (Admiralen Peak Formation and Dufayel Island Group) and associated intrusions (Wegger Peak Group) (Birkenmajer *et al.*, 1982a, b; 1986).

THE ZNOSKO GLACIER FORMATION AND GEOLOGICAL SETTING

The Znosko Glacier Formation is the oldest lithostratigraphic unit of the Cardozo Cove Group (Birkenmajer, 1980a, b; 1982) and its basement is unknown. More than 500 m thick, this formation is represented mainly by basaltic andesite lavas that predominate over fine-grained pyroclastic rocks. Petrified wood fragments and ripplemarks were observed within the sediments.

At the inner Ezcurra Inlet, the Znosko Glacier Formation underlies the Dufayel Island Group, composed by the Gdynia Point and Dalmor Bank formations, from which it is separated by a conspicuous angular unconformity. The oldest formation is represented by coarse to very coarse agglomerate and edgewise conglomerate, often of debris-flow type. The youngest Dalmor Bank Formation is mainly composed by tuffaceous rocks with intercalations of basaltic andesite lavas (Birkenmajer, 1980a; Birkenmajer *et al.*, 1982a).

In the type area, near Mackellar Inlet (Fig. 2), the Znosko Glacier Formation is locally overlaid by the Admiralen Peak Formation (the upper lithostratigraphic unit of the Cardozo Cove Group) with a slight angular unconformity. The younger formation is at least 40 m thick (erosional upper boundary) and consists in its lower part of tuffaceous beds with fossil plants, crab-burrows, load-and flute-casts suggesting sedimentary processes under restricted shallow marine conditions. The upper part is represented by a massive basaltic andesite lava flow (Birkenmajer, 1982).

The Wegger Peak Group is represented by plutonic bodies of quartz-gabbroic through quartz-dioritic to granodioritic composition that cut through the Znosko Glacier Formation (Birkenmajer, *op. cit.*).

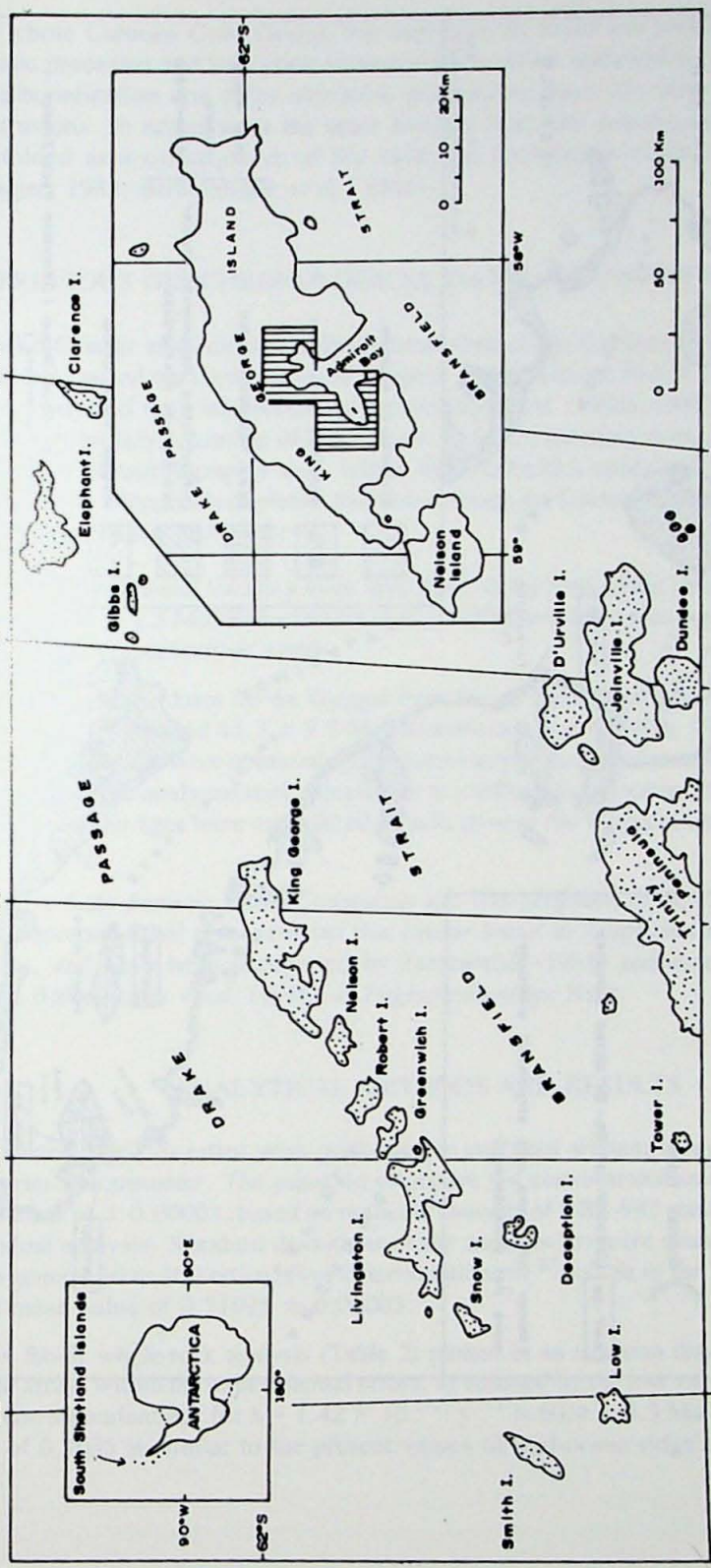

FIG. 1: Key map to show location of King George Island in South Shetland Islands and the area where the Znosko Glacier Formation crops out (Inset - see Fig. 2).

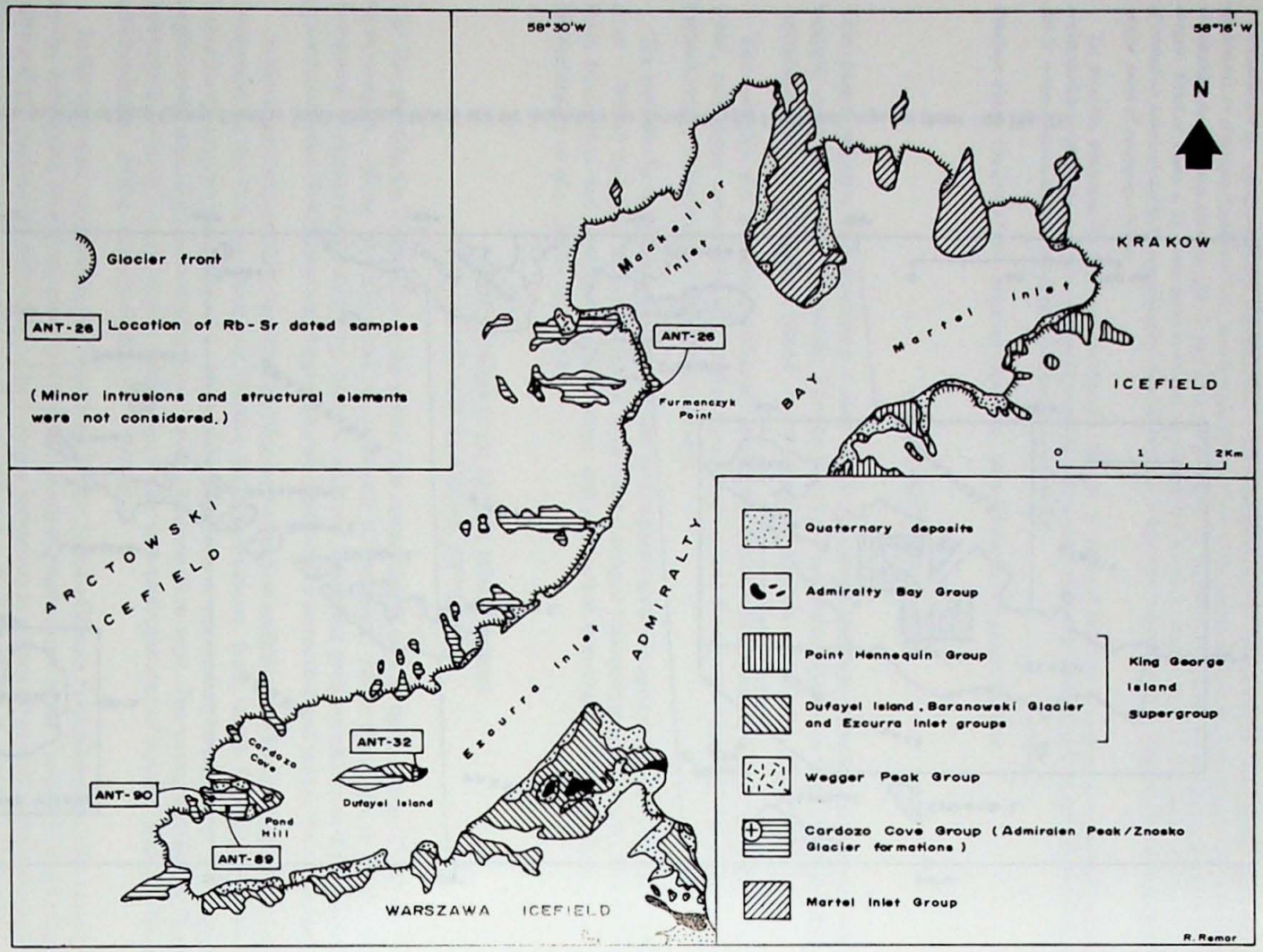

Fig. 2: Schematic geological map of Admiralty Bay region (after Birkenmajer, 1982) with location of dated samples.

In the whole Cardozo Cove Group, but mainly in its lower and middle parts, evidences of metasomatic processes and low-grade metamorphism occur, indicated by a widespread chloritization, carbonatization and other alteration phenomena, specially close to the Wegger Peak Group intrusions. In addition, at the inner Ezcurra Inlet, the volcanic complex in question is strongly folded as a consequence of the strikeslip deformation of the Ezcurra Fault system (Birkenmajer, 1982; Birkenmajer *et el.*, 1986).

PREVIOUS GEOCHRONOLOGICAL DATES AND INTERPRETATIONS

Both Znosko Glacier and Admiralen Peak formations of the Cardozo Cove Group, have K-Ar dates available carried out on whole-rock samples. The results are 56.8 ± 1.2 Ma and 43.7 ± 4.8 Ma, respectively and were interpreted by Birkenmajer *et al.* (1982a; 1986) as apparent ages as a consequence of tertiary reheating of older lavas. In fact, a resetting events is strongly suggested for the younger lithostratigraphic unit, whose date "coincides rather well with two out of three K-Ar dates of the Wegger Peak pluton that cuts through the Cardozo Cove Group" (Birkenmajer *et al.* 1986) (see below and Table 1).

From the Dufayel Island Group a thick lava flow, at the base of the Dalmor Bank Formation, was dated at 51.9 ± 1.5 Ma (Birkenmajer *et al.*, 1982b) and this value is probably related to the cooling after the crystallization event.

There are three K-Ar dates for the Wegger Peak Group intrusion at the Mackellar Inlet: 31.7 ± 0.9 Ma; 43.5 ± 4.8 Ma and 43.7 ± 9.8 Ma (Birkenmajer *et al.*, 1982a; 1986). The first and the second diverging results were obtained on the same sample, and the discrepancy was explained by inhomogeneity of the analyzed rock sample due to a differentiation phenomenon (Birkenmajer *et al.*, 1986). The older ages were considered as indicative of the Wegger Peat intrusion's emplacement and cooling.

A tentative Late Jurassic Early Cretaceous age was proposed to the Cardozo Cove Group, based on numerous fossil plant remains that can be found in Admiralen Peak Formation's fine pyroclastics, and have been interpreted by Zastawniak (1981) and accepted by Birkenmajer (1982) and Birkenmajer *et al.* (1986) as *Pagiophyllum* sp. Heer.

ANALYTICAL METHODS AND RESULTS

The normalized $^{87}Sr/^{86}Sr$ ratios were performed in unspiked aliquots using a new multicollector VG-354 mass spectrometer. The assumed errors are not conventional standard deviations. The minimum error of ± 0.00003, based on replicate analysis of NBS-987 standard, was increased to the individual analysis. Standard deviations of the analysis (σ) were usually less than 0.00003, having in general 60 to 100 ratios. Five determinations of $^{87}Sr/^{86}Sr$ in the NBS-987 resulted in a weighted mean value of 0.71025 ± 0.00003.

The six Rb-Sr whole-rock analysis (Table 2) plotted in an isochron diagram (Fig. 3) exhibit a very linear array, within the experimental errors, as stressed by the low value for MSWD of about 0.5. The correspondent age for $\lambda = 1.42 \times 10^{-11}\ y^{-1}$ is 60.4 ± 5.3 Ma and the initial ratio for $^{87}Sr/^{86}Sr$ of 0.7035 is similar to the present values of mid-ocean ridge basalt.

Table 1

PREVIOUS GEOCHRONOLOGICAL DATES OF THE CARDOZO COVE, DUFAYEL ISLAND AND WEGGER PEAT GROUPS:

	Sample nº	Site	Lithostratigr. unit	Rock type	% K	$40_{Ar\ rad}$ (%)	Age (Ma)	R
Wegger Peak Group	A-224	Wegger Peak	Wegger Peak Group	diorite	3.59	70.3	31.7±0.9	1
	A-224			diorite	1.833	56.6	43.5±4.8	3
	A-227			qz-diorite	1.461	55.6	43.7±9.5	3
Dufayel Island Group	A-451	Dufayel Island	Dalmor Bank Formation	basaltic andesite	4.23	74.75	51.9±1.5	2
Cardozo Cove Group	A-244	Admiralen Peak	Admiralen Peak Formation	basaltic andesite	1.488	64.4	43.7±4.8	3
	A-452	Dufayel Island	Znosko Glacier Formation	andesite	4.55	87.35	56.8±1.2	1

R(Ref.): 1- Birkenmajer *et al.*, (1982a);
2- Birkenmajer *et al.* (1982b);
3- Birkenmajer *et al.* (1986).

Rb-Sr isochron diagram for the Znosko Glacier Form.

Table 2

RB-SR ISOTOPIC ANALYSIS FOR THE ZNOSKO GLACIER FORMATION:

Sample n°	Site	Rock Type	Rb (ppm)	Sr (ppm)	$^{87}RB/^{86}Sr$	$^{87}Sr/^{86}Sr$
Ant-26C	Furmanczyk Point	basaltic andesite	129.9	467.4	.8038 ± .0089	.70417 ± .00004
Ant-25G			55.4	527.4	.3041 ± .0058	.70381 ± .00005
Ant-26I			58.9	638.8	.2667 ± .0046	.70372 ± .00005
Ant-32C	Dufayel Island		28.5	542.9	.1520 ± .0026	.70359 ± .00005
Ant-89	Pond Hill		3.7	959.2	.01010 ± .0001	.70348 ± .00006
Ant-90B			15.7	625.4	.0724 ± .0010	.70360 ± .00017

AGE: 60.4 ± 5.3 Ma (see isochron diagram, Fig. 3)

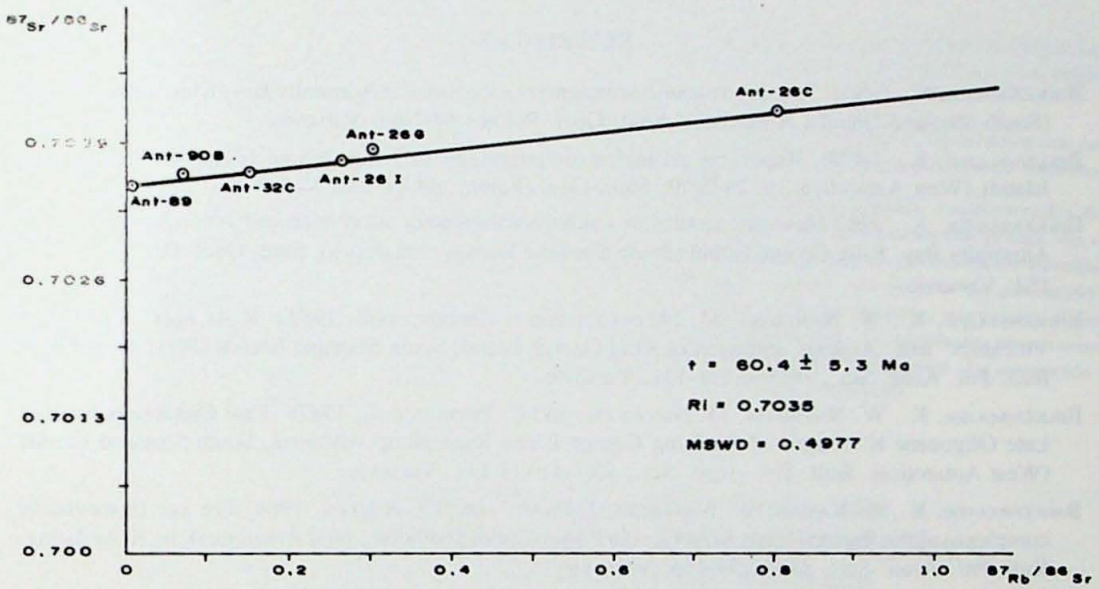

Fig. 3: Rb-Sr isochron diagram for Znosko Glacier Formation.

DISCUSSION AND CONCLUSIONS

Six K-Ar determinations obtained from the pertinent literature for reference purposes are given in Table 1, and the Rb-Sr analytical data of six samples from Znosko Glacier Formation are given in Table 2.

Mainly because of large variations in Rb contents, ranging from 3.7 to 129.9 ppm, significant differences were detected in Sr isotopic compositions. The linear array would be regarded as primitive, coeval and homogeneous initial $^{87}Sr/^{86}Sr$ lava flow, notwithstanding these conditions could be reached by metamorphism. In view of this, the calculated age of 60.4 ± 5.3 Ma, concordant with the K-Ar age of 56.8 ± 1.2 Ma would be the age of the Znosko Glacier lavas. In our opinion, it is very unlikely that a metamorphic process results in a homogeneous redistribution of ^{87}Sr abundances in the scale of the sample area.

In terms of the initial ratio of 0.7035, the basaltic andesitic lavas of Znosko Glacier Formation suggest a mantle derived material with minimal crustal contamination.

In conclusion, the K-Ar and Rb-Sr data for Znosko Glacier Formation indicate that both systems have been little disturbed by sucessive overlying lava flows. It seems that if this hipothesis is correct, the Mesozoic age based on the remains of a plant fossil *Pagiophyllup* sp. Heer is incorrect and also the K-Ar ages of basaltic rocks in such situations would be fairly valid.

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