RECONNAISSANCE 40Ar-39Ar AGE AND PALAEOMAGNETIC STUDY OF IGNEOUS ROCKS AROUND COYHAIQUE, S. CHILE (45'30-47°S)

N. PETFORD[1] & P. TURNER[2]

(1) School of Geological Sciences, Kingston University, Kingston KT1 2EE, UK
(2) School of Earth Sciences, University of Birmingham, Birmingham B15 2TT, UK

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From Eocene times onwards southern-central Patagonia has been the site of a number of ridge-trench collisions (Cande & Leslsie, 1986; Ramos and Kay, 1992). Subduction of a spreading oceanic ridge beneath continental lithosphere is a rare event and the potential effects of ridge subduction on the overriding South American plate are still poorly understood. In order to better constrain the timing of igneous activity and the possible effect of tectonic rotations formed in response to ridge subduction events, ^{40}Ar-^{39}Ar radiometric age dating and palaeomagnetic studies of key outcrops were undertaken in the region south of Coyhaique between 45'30 and 47°S.

REGIONAL GEOLOGY

The regional geology of the study area is summarised in Figure 1. The oldest rocks exposed in the region are Palaeozoic basement shales and phillites, overlain unconformably by volcanic arc rocks of the Jurassic Ibanez and Cretaceous Divisidero Formations (Suarez et al., 1994). During this time, the bulk of the Patagonoan batholith was believed to have been emplaced, although recent K-Ar and Rb-Sr ages (Pankhurst & Herve, 1994), supported by new data presented here, suggest that granitoid magmatism continued well into the Tertiary. A major phase of igneous activity began at the end of the Cretaceous with the extrusion of the voluminous Patagonian flood basalts and associated minor intrusives (Petford et al, this volume).

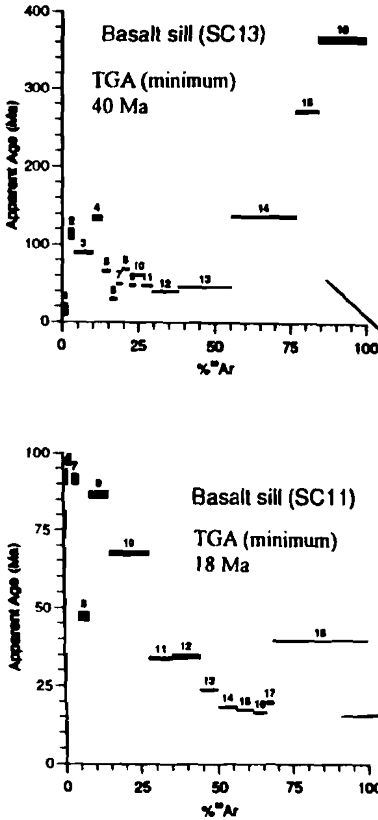
COYHAIQUE DYKE AND GRANITOID STOCK

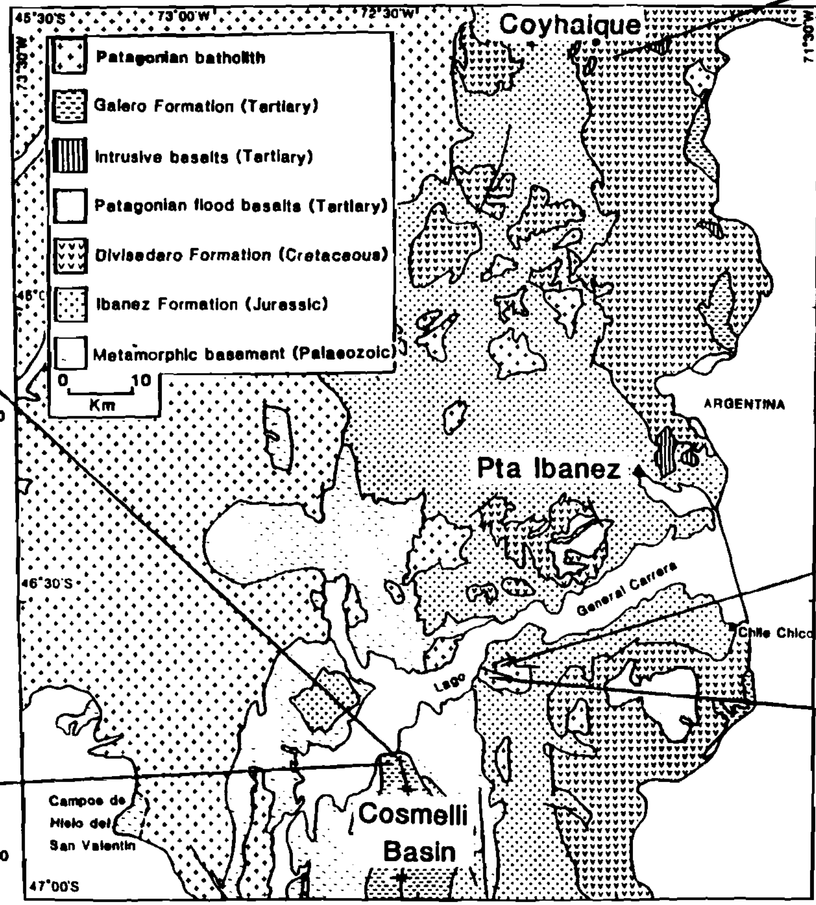
^{40}Ar-^{39}Ar ages

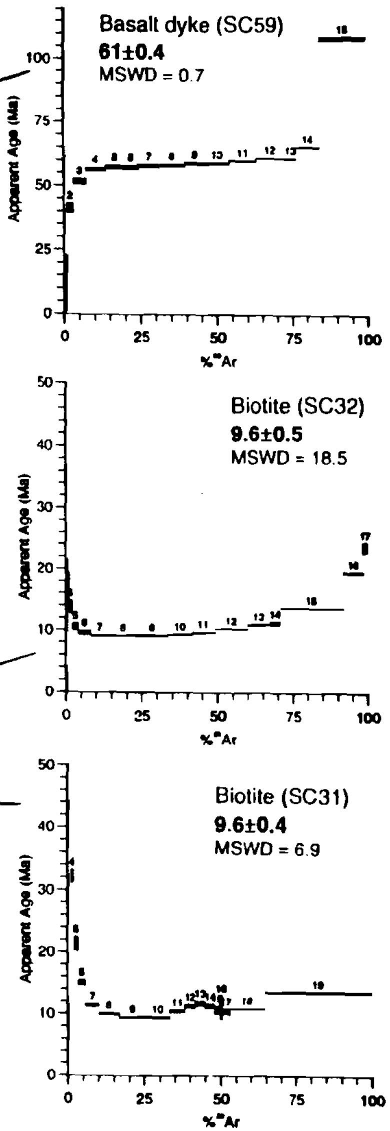
Eight samples (five whole-rock and two mineral separates) were selected for age dating. All quoted ages and related MSWDs are $^{36}Ar/^{40}Ar$-$^{39}Ar/^{40}Ar$ isochron ages. Errors (in Ma) are quoted at $\pm 1s$.

Figure 1 shows plots of the %39Ar gas release spectra, ages and geographical location of three whole-rock basalt samples SC 59, SC 13 and SC 11, along with two biotite separates SC 31 and SC 32 from the Patagonian batholith. The oldest rock dated in this study was the basaltic andesite dyke SC located 15 kilometres south east of Coyhaique. The dyke is part of a well exposed vertical swarm trending generally NNE-SSW that intrude into local black shales of the Cretaceous Divisidero Formation. The sample yields a well defined gas release spectrum, with a whole-rock (isochron) age of 61 ±

Fig. 1. ^{40}Ar-^{39}Ar gas release spectra for three basalts (whole-rock) and two mineral separates (biotites) from the Patagonian batholith around Coyhaique (45°30-47°00S). Samples SC 59, 32 and 31 are $^{36}Ar/^{40}Ar$-$^{39}Ar/^{40}Ar$ isochron ages ± 1σ. SC 13 and SC12 show minimum estimated total gas ages (TGA).







0.4 Ma (MSWD = 0.7) similar to the total gas age of 61.6 ± 0.6 Ma indicative of a true cooling age undisturbed by any subsequent thermal resetting.

Samples SC 32 and SC 31 are biotite fractions from a granitoid stock located to the east of the main Patagonian batholith that intrudes into volcanic rocks of the Ibanez Formation. The rocks are dioritic with SiO_2 contents of 52.49 and 54.63 wt% respectively. Biotite 40Ar-39Ar mineral isochron ages are identical within error at 9.6 Ma. This unexpectedly young age places the stock in the Mid Miocene, and is further evidence for a young component within the Patagonian batholith. Although their total gas ages are broadly similar (9.6 ± 0.5 and 10.4 ± 0.4 Ma), their relatively high MSWDs of 6.9 and 18.5, and slightly erratic gas release spectra indicate mild disturbance may have occurred during or after cooling.

Palaeomagnetic Results

Palaeomagnetic results for samples 59 (Coyhaique dykes) and, 31 and 32 (granitoid stock) are characterized by initial NRM direction with steep negative inclinations. During partial thermal demagnetization over 80% of the remanence is lost on heating to 350°C. Above this temperature there are no systematic directional changes and vector analysis indicates that the characteristic remanence lies in the temperature range 100-400°C.There are insufficient palaeomagnetic data to calculate a realistic virtual geomagnetic pole for the Coyhaique dykes.

The granitoid stock shows more complex palaeomagnetic properties than the Coyhaique dykes. The initial NRM directions have southerly declinations with a relatively steep positive inclination (reversed polarity). During thermal demagnetization a low blocking temperature component is removed between 0 and 100°C. Above this temperature there is usually a slight relative increase in NRM intensity followed by a sharp drop near the Curie temperature of magnetite (580°C). Vectorial analysis indicates that the NRM comprises two major components, one with a lower unblocking temperature spectrum between 100-400°C has a north easterly declination.and shallow negative inclination. The mean direction of *Dec*: 182; *Inc*: 64; *n* 5 ;α_{95} 6.9. The direction corresponds to a Virtual geomagnetic Pole at *Lat*: 88S *Long*:160 SE with *Dp* 8.8 and *Dm*11.0.

INTRUSIONS IN THE COSMELLI BASIN

The Cosmelli basin is located above a segment of continental crust that has experienced several ridge subduction events over the last 15 Ma. Recently, Flint et al., (1992) have interpreted the Cosmelli basin as a foreland basin that formed in response to ridge subduction processes.

^{40}Ar-^{39}Ar ages

Comparison with the other sample spectra in Figure 1 shows that the gas release spectra of two basaltic sills SC 13 and SC 11 intruding the Cosmelli basin sediments are severely disturbed. Indeed, it was not possible to obtain an isochron plot for either sample, due to the high degree of scatter of individual gas fraction ages. Such scatter is characteristic of rocks that have undergone extensive isotopic resetting of radiogenic argon after initial cooling, with the 'U'-shaped gas release spectra of both samples diagnostic of excess radiogenic argon. Total gas ages (the sum of all the individual gas fractions) comparable with ages that would be obtained by K-Ar dating are 146 Ma for SC 13 (Tithonian) and 31.6 Ma for SC 11 (Oligocene). Clearly the older of these ages is at odds with established stratigraphic correlations within the Cosmelli basin, although they do show the advantage of ^{40}Ar-^{39}Ar technique over K-Ar dating in identifying samples that have had their primary ages reset. Taking the total gas age of the *lowest age steps* from both spectra gives some indication of the *possible maximum age* of the sample. This is about 40 Ma for SC 13 (steps 7, 9, 11,12,13) and about 18 Ma for SC 11 (steps 14-17). Although no significant emphasis should be placed on these age estimates (they account for approximately 35 and 20% of total 39Ar released), they are nevertheless closer to assumed stratigraphic ages based on correlations between intercalated sediments.

Palaeomagnetism

Palaeomagnetic data for the basalt sills is different. The Lower Sill (SC 11) has reversed polarity whereas the Upper Sill (SC 13) is of normal polarity. There are also important directional differences between the two. The initial NRM of SC 11 has a northerly declination with steep negative inclination. During partial; thermal demagnetization there is a near exponential decay of the NRM intensity and above 150°C there is only a single component of magnetization. The lower sill shows a smooth demagnetization trend with a slight concave-up curve. The median destructive field lies at about 200mT. The othogonal vector plot shows the presence of only a single component of magnetization consistent with those seen in the partial thermal demagnetization. The mean direction calculated for the combined data is *Dec*: 155 *Inc*: 71 n 12 α_{95} 7.3 The corresponding VGP is *Lat*: 72S *Long* 339E with *Dp*11.1 and *Dm* 12.7

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