AGE AND Al-IN-HORNBLENDE GEOBAROMETRY IN THE NORTH PATAGONIAN BATHOLITH, AYSEN, CHILE.

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Introduction

The North Patagonian Batholith is a complex elongated batholith in the Andes of Southern Chile, parallel to the continental margin and forming the basement of the present day volcanic arc. In the Aysén region (43° to 47°S Lat.), it is >100 km wide, and exhibits a marked E–W age zonation. Pressures of crystallization, determined mainly by the Al-in-hornblende geothermometer, are presented and compared with the ages of crystallization determined by the Rb-Sr whole-rock method. The pattern of calculated uplift/denudation rates is related to the tectonics of the continental margin.

Geochronology

A summary of available geochronological data for the granitoids of Aysén was presented by Pankhurst and Hervé (1994), revealing a systematic spatial distribution of ages within the batholith. The western margin of the batholith is of Early Cretaceous age, particularly in the southern part of the area. The eastern margin of the batholith is mainly mid-to-Late Cretaceous, although Early Cretaceous ages are also present in the northern area and plutons with ages close to 10 Ma also occur as satellite bodies to the east of the main batholith. The median zone is characterised by plutonic events at ca. 45 Ma, 25–15 Ma and 10 Ma or less, representing discrete stages in the establishment of the present-day subduction regime (Pankhurst et al., 1995).

Geobarometry

Crystallization pressures were calculated from electron microprobe analysis of hornblendes from 18 samples (Schmidt, 1992). All samples contained the buffer mineral association prescribed for valid calibration of the method. Geothermometric determination (Blundy and Holland, 1990) indicated essentially magmatic temperatures of mineral equilibration in all samples (600–774°C). Spatial distribution of samples was limited by the compositional and sampling restrictions. The results are shown in

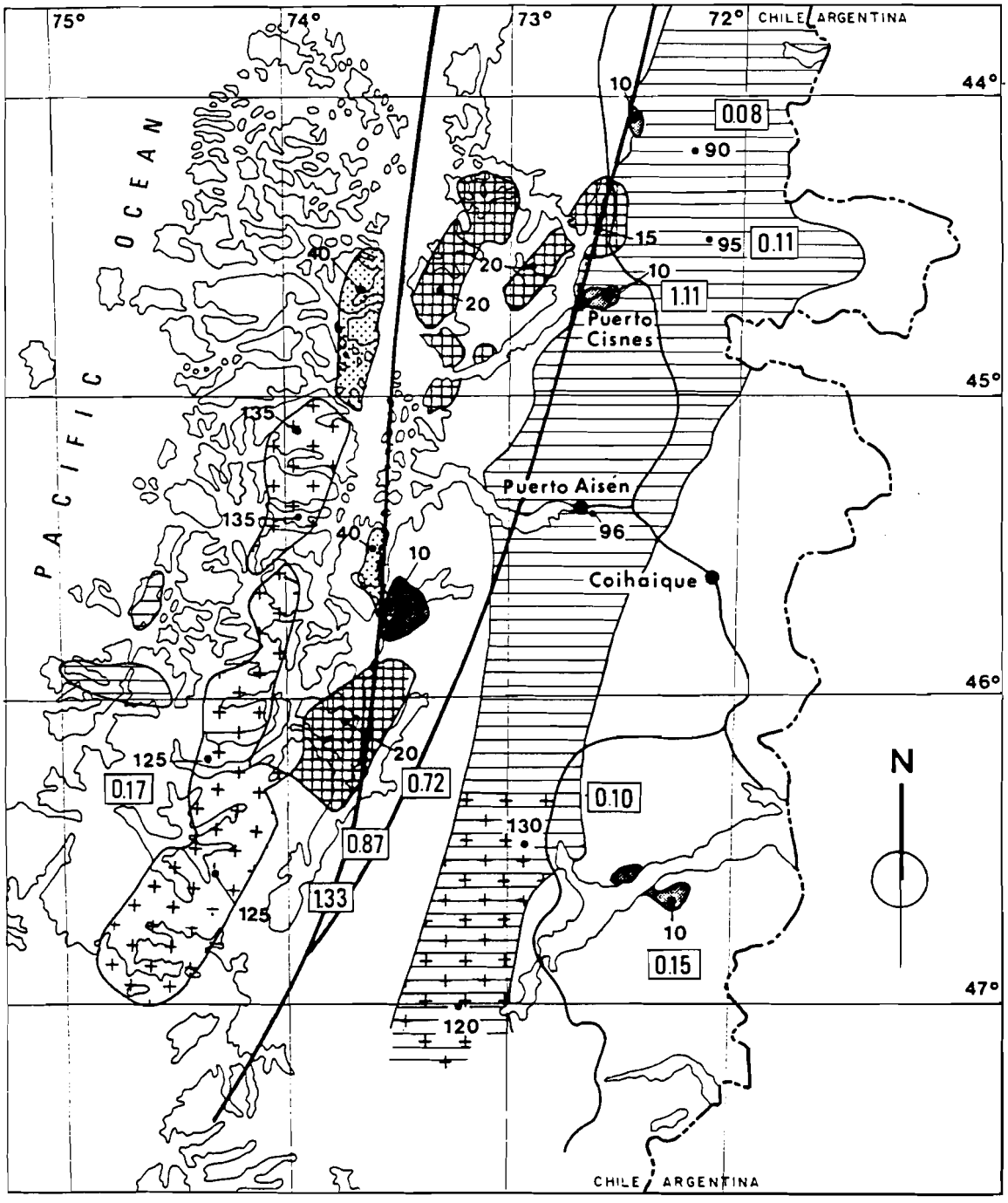
75°
74°
73°
72°
CHILE
ARGENTINA
44°
45°
46°
47°
PACIFIC OCEAN
Puerto Cisnes
Puerto Aisén
Coihaique
0.08
0.11
1.11
0.17
0.72
0.87
0.10
0.15
N
CHILE
ARGENTINA
Early Cretaceous
Late Cretaceous
Liquiñe Ofqui fault zone
Eocene
Early Miocene
Late Miocene
Rb-Sr ages (ma.)
Uplift/denudation rate (mm/yr)

Table 1, together with calculated average uplift rates asuming the indicated ages of crystallization of the magmas. The suggested error in calculated pressures is ±0.5 kb (i.e. 1.9 km in terms of depth). Most of the samples were collected at sea level, those inland were at altitudes less than 0.7 km.

	Pressure (kb)	Depth (km)	Age (Ma)	Uplift/ denudation rate (mm/yr)
Eastern Margin				
Lago Verde	1.9	7.0	88	0.08
Rio Toqui	2.8	10.4	96	0.11
Rio Murta	3.5	12.9	130	0.10
Las Llaves	0.4	1.5	10	0.15
Central Part				
Rio Cisnes	3.0	11.1	10	1.11
Bahia Erasmo	4.7	17.4	20	0.87
Bahia Erasmo	7.2	26.6	20	1.33
Bahia Exploradores	3.9	14.4	20	0.72
Rio Palena*	4.2	15.5	5	3.11
Cholgo*	4.8	17.8	10	1.78
Rio Mariquita*	2.3	8.5	10	0.85
Western Margin				
Estero Vidal	5.6	20.7	124	0.17

Table 1. Pressure, depth and uplift/denudation rates as determined in this study. Pressures are averages for 2 to 6 hornblende analyses for each sample (Lago Verde is an average of 5 samples). Pressure for Rio Cisnes was derived on phengite. An asterisk (*) denotes samples from north of the area of Fig. 1.

Discussion and conclusions

The crystallization pressures obtained are within middle to upper crustal range, consistent with the epizonal to mesozonal characteristics of the studied intrusive rocks. The shallowest intrusions are those of Lago Verde and Paso Las Llaves, both of which have well developed miarolitic cavities, considered indicative of shallow emplacement. Pressures determined by fluid inclusion analysis in the Paso Las Llaves pluton (Vargas and Hervé, 1995) are consistent with the Al-in-hornblende results. The rest of the plutons were emplaced at depths greater than 10 km and some more than 20 km.

The average uplift/denudation rates obtained are around 0.1 to 0.2 mm/yr for both western and eastern marginal zones of the batholith. Deeper emplacement of plutons in the western margin is in keeping with their intrusion into Late Palaeozoic metamorphic rocks, whereas those of the eastern margin intrude volcanic sequences deposited over such basement. Thus, the present day exposed margins of the batholith represent different levels of emplacement and erosion.

Average uplift rates one order of magnitude higher (0.7 to 3.1 mm/yr) were calculated for the Tertiary plutons in the central zone of the batholith. Deeper levels of emplacement are also indicated for these plutons (average 16 km) compared to those of the Late Cretaceous eastern margin (10 km). The Miocene plutons are spatially related to the Liquiñe-Ofqui Fault Zone, where tectonic activity has been effective from at least

Mid-Tertiary times (Hervé et al., 1995). Igneous bodies were differentially transported upwards at high rates along this dextral strike slip fault zone in the Late Cenozoic, a feature characteristic of "flower" structures in transpressive environments. This central zone with rapid uplift rates coincides with the present main topographic range of the Andes, for which Holocene uplift rates of 4–10 mm/yr have been independently suggested (Hervé & Ota, 1993).

Uplift/denudation rates for the last 20 Ma are much higher in the Andes of Aysén than in the main Andean cordillera near Santiago (0.15–0.26 mm/yr; Skewes & Holmgren, 1993). In contrast, the height of the range is much greater in the latter area (6 km) than in Aysen (3 km). If subduction parameters were comparable in both areas, climatic difference may have been a factor in allowing and sustaining higher uplift/ denudation rates in Aysén.

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