PLUTONISM AND THE GROWTH OF ANDEAN CRUST AT 9° S FROM 100 TO 3 MA.

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RESUMEN: Chemical variations into the continent in plutonic rocks, 9° S Peru, do not conform to models involving increasing continental crust components etc. They relate to melting of new basaltic crust at increasing depth into the continent as the thick keel of the Andes evolved over the period 100-5 Ma.

KEY WORDS: Cordillera Blanca Batholith, Coastal Batholith, Transverse Variations, Trondhjemite.

INTRODUCTION

The Andes have been considered to be the archetype of a mountain belt produced by subduction of oceanic crust beneath continental crust. In Peru magmatism is confined to belts parallel to the present trench and coast (Fig. 1) and from 100-3 Ma there was a migration of the plutonic locus with time towards the interior. Such progressions are usually coupled with a change in composition considered to reflect thickening, reworking and uplift, which according to some authors reflects a fundamental plutonic cycle (eg. Pitcher, 1983). Thus the Mesozoic batholiths of western north America show an eastwards change in composition and isotopic signature related to the leading edge of the continental shield. Chemically based models related to island/continental arcs indicate transverse variations in elements and isotopes away from the subduction zone (Saunders et al., 1980). Here we describe the transverse changes in chemistry of the plutonic rocks in the Andes of Peru (9° S) which are not consistent with generalised models but relate to a change in source and depth of melting.

GEOLOGICAL SETTING

The Cordillera Blanca Batholith (CBB) lies 300 km inboard of the Coastal Batholith (CB, Fig. 1) and together they represent almost continuous plutonism over the period 100 to 3 Ma, apart from a gap between 36-13 Ma which is filled by minor intrusions lying between the two batholiths. Here we contrast the two batholiths and relate the differences to the evolution of the Andean margin over the period 100-3 Ma. Aspects of the geological setting are outlined below.

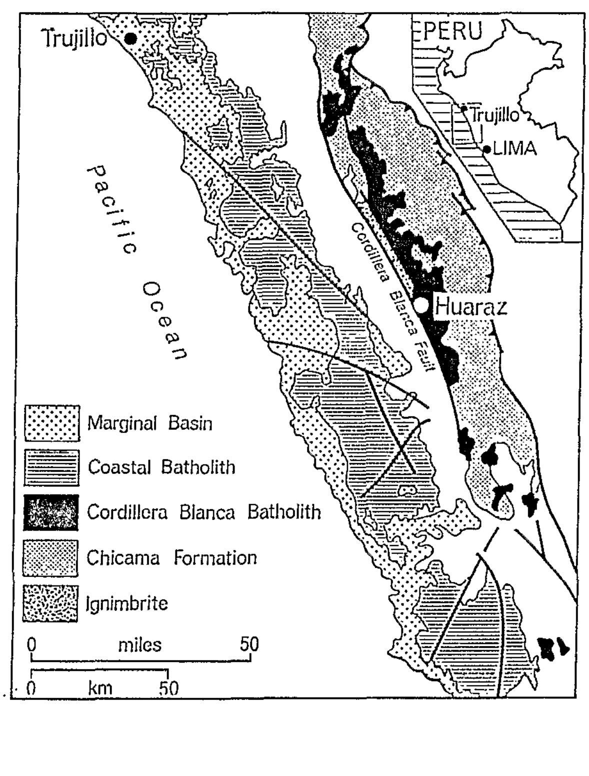

Fig. 1. Simplified map of area north of Lima showing Cordillera Blanca Batholith lying inboard of the Coastal Batholith.

Coastal Batholith	Cordillera Blanca Batholith
Intruded - along continental margin; with Andean trend;	Intruded - over deep crustal keel (60km) with Andean trend;
within Albian marginal basin, + 10km, (entirely volcanogenic); along a major crustal lineament, 1600km long;	within axial zone of Jurassic basin (mainly graphitic shales + sandstones) along major, deep megafault + 400km long
within the extensional lineament, 100-37Ma;	within transtensional strike-slip pull apart, 12-3Ma; Uplift in Miocene.
Uplift in U. Cretaceous and L. Tertiary.	

Specifically, both batholiths were intruded into basinal systems related to continental margin extension which started in the Jurassic at least. Furthermore the crustal source for both magmas was *new basaltic* material, at the bottom of the marginal basin for the CB and at the bottom of the thick (> 60 km) Miocene keel of the Andes for the CBB.

Both batholiths are calc-alkaline with tonalitic rocks dominating the CB and granitic rocks with trondhjemitic character (Atherton & Petford, 1993) dominating the CBB.

The increase in peraluminosity in the CBB is not related to an old crustal component in the source. Indeed there is no old crust beneath this sector of Peru (Atherton & Petford, 1993). Rather it relates to late deformation associated with fluid infiltration and alkali loss (Petford & Atherton, 1992). Variations in composition inboard from the continental lip are shown below.

West → East

Coastal Batholith → Cordillera Blanca Batholith

Into the continent with increasing distance from present trench

No K/Si, Rb/Si, Th/Si, Ce/Si increase inboard

but increase in Na_2O, Sr, Ta, A/CNK, Ce_N / Yb_N and subtle decrease in CaO, Th, Y, Ce.*

** A/CNK increase relates to late high level deformation and fluid penetration*

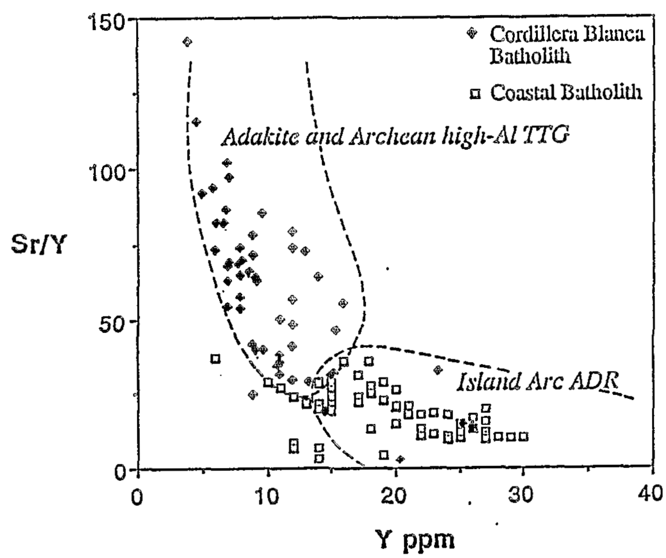

Fig. 2. Plot of Sr/Y vursus Y for rocks of the Cordillera and Coastal Batholiths. Island arc andesite-dacite rhyolite fields and Adakite Archean high-Al tonalite-trondhjemite-granodiorite fields are shown

DISCUSSION: BASALT TO BATHOLITH

Transverse variations at 9° S in Peru do not conform to any of the simple models put forward for continental margins. Rather, compositional variations into the continent relate to shallow melting (< 10 km) of Albian basaltic crust to produce the CB (Atherton, 1990) and deep melting (ca. 50 km) of the newly thickened basaltic keel of the Andes in the Miocene to produce the CBB (Atherton & Petford, 1993). CB magmas are calc-alkali with compositions determined by slab enriched mantle mineralogies with residues of mainly olivine and pyroxene (Fig. 2). In contrast the Na-rich magmas of the CBB are more alkalic and relate to garnet-hornblende residues in the source. They are thus similar to adakite and Archean high Al-TTG (Fig. 2 and Atherton & Petford, 1993). Similar Tertiary Na-rich plutons in Chile suggest that this transverse pattern is not unique to Peru. However, it is clear that this variation will only relate to sectors along the continental margin where the source is basaltic and Precambrian lower crust is absent (see Petford et al., this volume).

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