GEOCHEMICAL CONSTRAINTS ON THE EVOLUTION OF THE SOUTHERN PERUVIAN COASTAL BATHOLITH: TOQUEPALA SEGMENT

Richard A. OLIVER [(1)], Nicole VATIN PERIGNON[(2)], Francine KELLER[(2)] & Guido SALAS[(3)]

(1) Institut Laue-Langevin, B.P.156, Avenue des Martyrs, 38042 Grenoble Cedex, France
(2) Laboratoire de geologie, UA 69 CNRS, Université Joseph Fourier, 15, Rue Maurice Gignoux, 38031 Grenoble Cedex, France.
(3) Universidad nacional San Augustin, Casilla 1203, Arequipa, Peru

RESUME

Key words: Batholith, Toquepala, Ilo, Punta Coles, Yarabamba, Quento, REE

INTRODUCTION

The Coastal Batholith of the Western Cordillera in Peru stretchs for some 1600km along the length of the oceanic trench, and has been extensively studied by a number of workers. The southern part of this magmatic structure has been separated into two segments (Arequipa and Toquepala) which have further been subdivided into a number of super units which were emplaced as discreet magmatic pulses. These segments have been studied by several workers (Moore, 1984; Mukaza, 1986*a*, 1986*b*; Boily et al., 1989). This paper presents new geochemical and isotopic data on intrusives from the Toquepala segment and attempts to distinguish the evolution through time of the different super units involved.

GEOLOGICAL SETTING

Three super units make up the Toquepala segment, Punta Coles, Ilo and Yarabamba. The Punta Coles super unit is patchily exposed as intrusions of gabbroic to dioritic plutons mainly lying along the coast and intruding Jurassic volcanic rocks of the Chocolate and Guaneros formations, and rarely rocks of the Precambrian basement. The Ilo super unit, which consists of plutons ranging in composition from tonalite to granodiorite and even some rare granites, cuts the intrusives of the Punta Coles super unit but generally lies further inland where it cuts the same volcanic formations as before. It is often overlain by sediments from the Moquegua formation and the Toquepala volcanics. The Yarabamba super unit lies much further inland and is generally more evolved than the other two, consisting of plutons of granodiorite to granite which have intruded the earlier intrusives of the Arequipa segment , the Jurassic volcanics as well as the sediments of the Late Jurassic to Early Cretaceous Yura Group.

Within these three super units we present data from the Punta Coles, Ilo, Punta de Bonbon, and El Fiscal plutons in the west and the Coalaque and Quento plutons in the east.

GEOCHEMISTRY

Major and trace and REE element data from the six plutons are presented. Multi-element (Figure 1) and REE (Figure 2.) patterns. The multi-element diagrams show an enrichment in the incompatible LIL elements, typical of calc-alkaline rocks. The chondrite normalised REE patterns show enrichment of the light REE and flattening of the heavy REE with small Eu negative anomalies for the more evolved rocks. The exception to this being the older and more basic Punta Coles unit which shows a marked positive Eu anomaly. The patterns indicate an evolution from the oldest (Punta Coles) to the youngest (Quento).

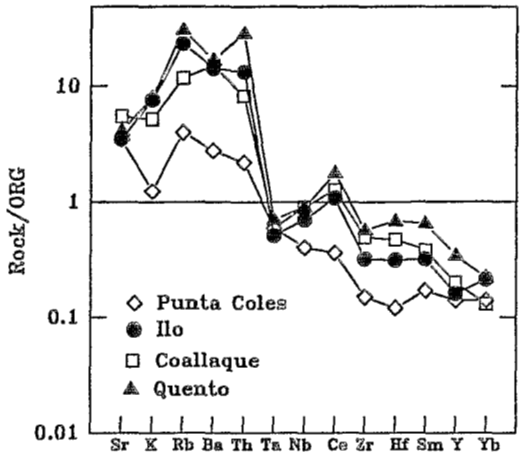

Figure 1. Multi-element diagram of the Toquepala segment.

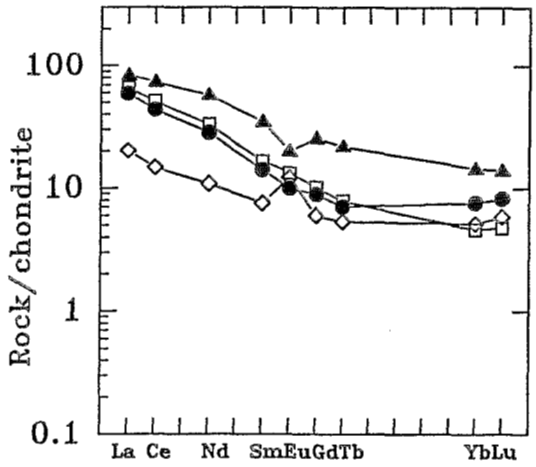

Figure 2. Rare Earth Element patterns for the Toquepala segment

Trace element discriminant diagrams indicate that magmas, from sources close to mantle composition have undergone crystal fractionation with only small amounts of crustal contamination., i.e. Hf/Zr ratios close to mantle values. (Figure 3.)

ISOTOPE GEOCHEMISTRY

Rb/Sr isotope data for the Ilo super unit gives an age of 91.9 ± 9 Ma (Figure 4.). this is somewhat younger than that found by Beckinsale et al., 1985 who give ages of 112 ± 32 Ma. An errorchron of three points for the Quento pluton, the pluton lying the furthest to the east of the investigated plutons, gives an age of 22.8 ±2 Ma (Figure 5.) which classes this pluton, in the Oligocene- Miocene

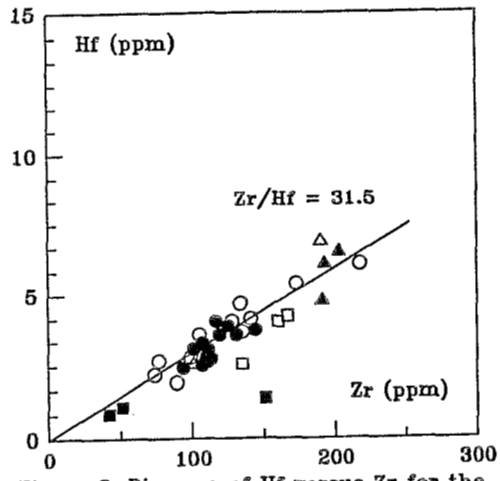

Figure 3. Diagram of Hf versus Zr for the Toquepala segment.

Tacaza group of Sebrier et al.,(1988). $^{87}Sr/^{86}Sr$ ratios are generally more evolved than those reported by Beckinsale et al. (1985) and Boily et al.(1989). Boily et al., (1989) defined three groups for the Arequipa-Toquepala segments from εNdt versus εSrt ratios (Figure 6.).

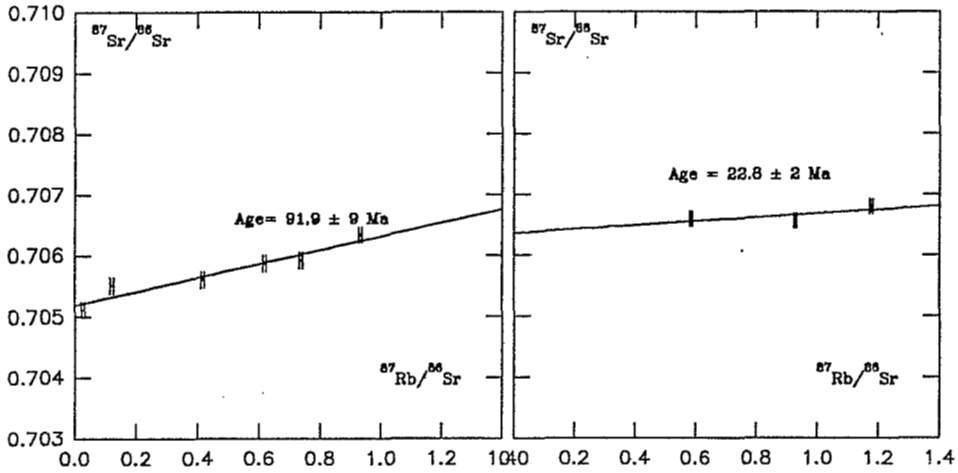

Figure 4. Rb/Sr isochron for the Ilo super unit, Toquepala segment

Figure 5. Rb/Sr errorchron for the Quento pluton,, Toquepala segment

Whilst in general terms the groups occupy roughly the same fields, a major difference occurs with the Punta Coles unit showing a more evolved or contaminated signature in Group 2; Our Group 3 values are from the Quento pluton which could have derived from old, highly enriched mantle or as is more likely, has absorbed deep lying Precambrian crust. Although this must have had a very low Rb/Sr ratio.

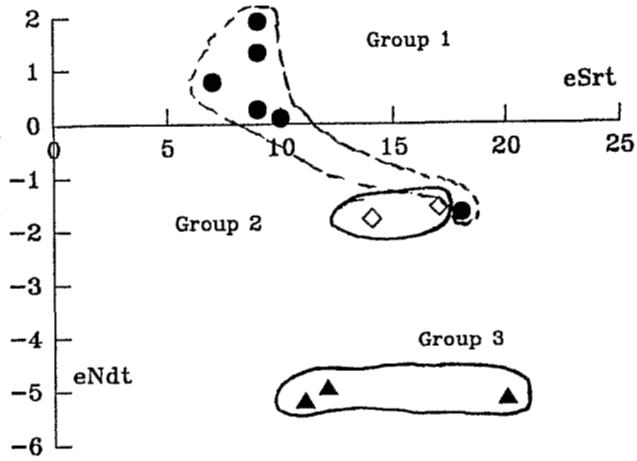

Figure 6. εNdt versus εSrt for the Toquepala segment.

CONCLUSIONS

New geochemical and isotopic data for rocks from the Toquepala segment of the Southern Coastal Batholith, Peru, indicate an evolution through geologic time for the sources of these intrusions. Initial isotopic ratios somewhat higher than previously published data but non the less show the same indications. The Quento pluton outcropping at the head of the Tambo valley appears to be somewhat younger than the rest of the Yarabamba super unit and can be ascribed to the Tacaza group.

REFERENCES:

BECKINSALE R.D.,SANCHEZ-FERNANDEZ A.W.,BROOK M.,COBBING E.J.,TAYLOR W.P. and MOORE N.D., 1985, Rb-Sr whole rock isochron and K-Ar age determinations for the Coastal Batholith of Peru in Magmatism at a Plate Edge, edited by W.S.Pitcher, M.P.ATHERTON, E.J.COBBING and R.D.BECKINSALE, pp 117-202, Blackie, Glasgow 1985.

BOILY M.,BROOKS C. and LUDDEN J.N., Chemical and Isotopic Evolution of the Coastal Batholith of Southern Peru, J. Geophy. Res., Vol 94, No B9, pp 12483-12498

MOORE N.D. 1984, Potassium-Argon ages from the Arequipa Segment of the Coastal batholith of Peru and their correlation with regional tectonic events. J. Geol. Soc. Vol141, 3, pp511-520

MUKAZA S.B. 1986*a*, Common Pb isotopic compositions of the Lima, Arequipa and Toquepala segments in the Coastal batholith, Peru, implications for magma genesis. Geochim. Cosmochim. Acta, Vol 50, pp771-782

MUKAZA S.B. 1986*b*, Zircon U-Pb ages of super units in the Coastal batholith, Peru; implications for magnetic and tectonic processes. Bull; Geol. Soc. Amer , Vol 97, pp241-254

SEBRIER M.,LAVENU A.,FORNARI M. AND SOULAS JP., 1988, Tectonics and uplift in Central Andes (Peru, Bolivia and Northern Chile) from Eocene to present., Geodynamique, Vol 3(1-2), pp 85-106.