# THE AGE OF THE ZONGO PLUTON AND THE TECTONOTHERMAL EVOLUTION OF THE ZONGO SAN-GABAN ZONE IN THE CORDILLERA REAL, BOLIVIA.

Edward Farrar, Alan H. Clark and Silvia M. Heinrich

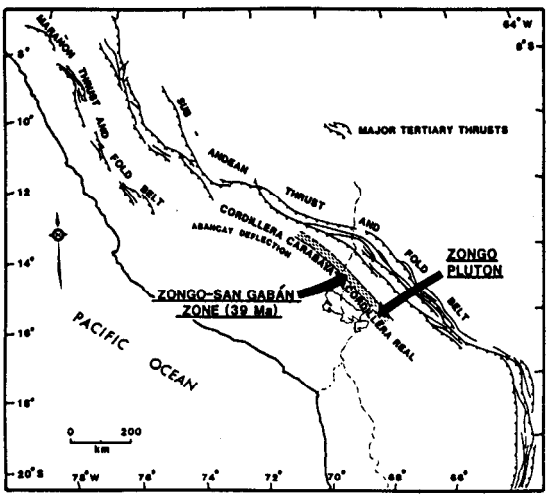
Dept. of Geological Sciences, Queen's University
Kingston, Canada, K7L 3N6

**Résumé**

Les mesures $^{40}Ar/^{39}Ar$ sur micas échantillonnés verticalement dans le pluton de Zongo (U-Pb, 225 Ma), montrent que les données discordantes K-Ar (rejeunissement NE) résultent de chrontours de muscovite et biotite orthogonaux, impliquant, il y a 39 Ma, une rotation de 90° de la zone Zongo-San Gabán.

## Introduction

The Cordillera Oriental of NW Bolivia and SE Peru is underlain by granitoid rocks of Permo-Triassic age (e.g., McBride et al., 1983; Laubacher, 1978) that intrude Paleozoic metasediments. However, Bard et al. (1974) assigned an "Eohercynian" age to the variably foliated Zongo pluton in the Cordillera Real, Bolivia (Fig. 1), on the basis of similarities with deformed rocks in central Peru and on its relationship to an apparent metamorphic culmination located in the metasediments NE of the pluton. Furthermore, in a SW-NE transect through the

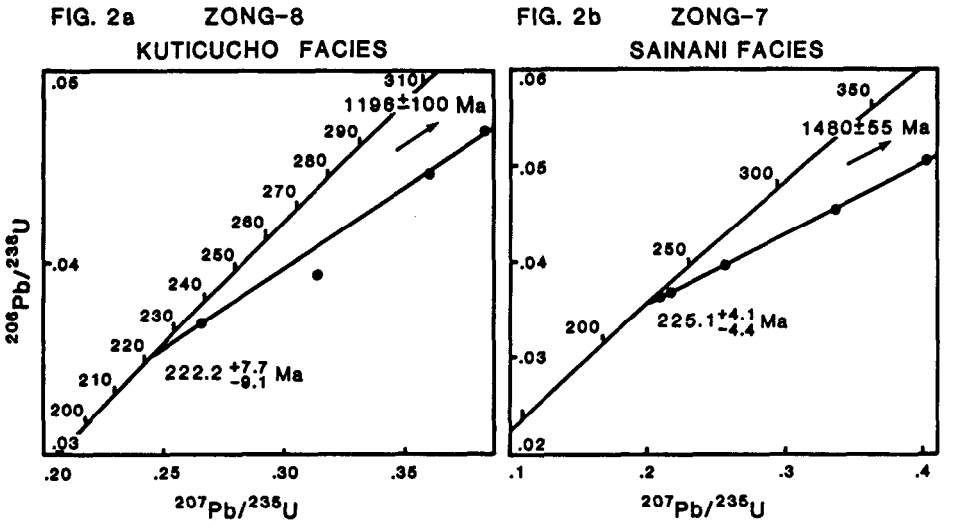


Zongo pluton, K-Ar and $^{40}Ar/^{39}Ar$, muscovite and biotite dates are widely discordant, each set younging monotonically toward the NE (McBride et al., 1987). Similar K-Ar age gradients have been documented further NW in the Cordillera Real (McBride et al., 1987) and on the NE flank of the Cordillera de Carabaya of SE Peru (Kontak et al., in prep.). Farrar et al. (1988) have termed this region of reset dates, which is ca. 20 km wide and over 450 km long, the Zongo-San Gabán Zone, and have ascribed the overprinting to a predominantly compressional tectonothermal event that occurred 39 Ma ago.

In this communication, we report two studies that bear on the nature of the tectonothermal event. First, to establish unequivocally the age of the Zongo pluton and its metamorphic aureole, we present the results of U-Pb dating of zircons from two phases of the pluton (Heinrich et al., 1988). Second, to establish the three-dimensional nature of the tectonothermal overprint, we report $^{40}Ar/^{39}Ar$ dates of samples collected above the valley of the Río Zongo.

## U-Pb and $^{40}Ar/^{39}Ar$ dating

The two-mica, monzogranitic-to-syenogranitic Zongo pluton comprises a pervasively foliated Kuticucho facies and, NE, a weakly foliated, Sainani facies. Distinct zircon populations were separated from samples of each facies, abraded to remove material that may have lost lead during the tectonothermal event that reset K-Ar dates, and analysed for U and Pb. The analytical results, shown graphically (Fig. 2) yield ages of




intrusion (lower concordia intercepts) of 222 and 226 Ma for the Kuticucho and Sainani facies, respectively. Poorly constrained upper intercepts are suggestive of an inherited zircon component of Proterozoic age.

New $^{40}Ar/^{39}Ar$ total fusion dates for biotite and muscovite from samples, collected at altitude above the valley floor in the Zongo transect, have been integrated with previously published K-Ar and $^{40}Ar/^{39}Ar$ dates (McBride et al., 1987) and unpublished $^{40}Ar/^{39}Ar$ dates (Heinrich, 1988). The combined biotite and muscovite data sets have been contoured in Figs. 3 and 4, respectively. The biotite "chrontours" are sub-

FIG. 3.

ZONGO BIOTITE CHRONTOURS

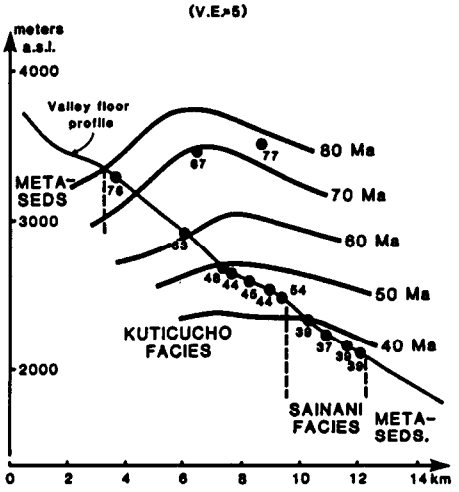
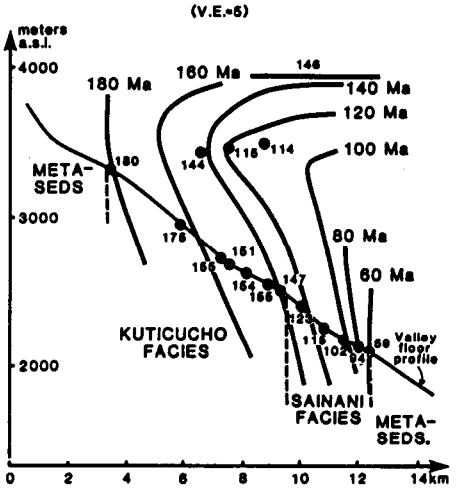



FIG. 4.

ZONGO MUSCOVITE CHRONTOURS




horizontal and young with increasing depth, whereas muscovite "chrontours" are vertical and young toward the NE.

## Discussion and Conclusion

The essentially identical U/Pb zircon dates (225 Ma) for the Kuticucho and Sainani facies of the Zongo pluton clearly indicate a Triassic age of intrusion, and, in contrast to the inference of Bard et al. (1974), imply that the wide metamorphic aureole in the metasediments NE of the Zongo body was also formed at that time. This result supports our geological observations which suggest that, in this transect, a vertical cross-section through the Zongo pluton, with progressively deeper parts to the NE, is exposed.

The most plausible explanation for the intersecting muscovite and biotite K-Ar chrontours is that both patterns are a result of heating from below, but that a ca. 90° rotation (counter-clockwise looking NW) of the Zongo intrusion occurred between the resetting times of muscovite and biotite. The total resetting of the biotites near the NE margin of the

intrusion occurred as the temperature of the rocks fell below the biotite blocking temperature (ca. 250°C) at 39 Ma (McBride et al., 1987). No muscovites in the Zongo transect are totally reset and therefore the blocking temperature of muscovite (ça. 350°C) was not reached. Thus, rotation of the panel occurred while the temperature was between approximately 300 and 250°C.

We attribute the tectonic rotation and the thermal effects in the Zongo transect and the tectonothermal overprint elsewhere in the Zongo-San Gabán Zone to crustal-scale shortening associated with the Late Eocene Incaic orogeny.

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