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TIMS U-Pb zircon geochronology at the CPGeo – USP: chemical and physical techniques applied to Precambrian granites of Bolivia

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INTRODUCTION

This study deals with the U-Pb technique by combining chemical (acid washing) and physical (abrasion) procedures in selected high temperature zircons of magmatic rocks. The results provide new insights for the zircon isotopic systematic by TIMS carried out at the Centro de Pesquisas Geocronológicas (CPGeo) of the Institute of Geosciences – USP.

The selected granitoids (S- and I- types) from the Bolivian shield are tectonically associated with the Mesoproterozoic evolution of the SW portion of the Amazonian Craton, in Brazilian territory (Cordani & Teixeira, 2007). Four granitic rocks were studied, cropping out nearby the towns of Monte Verde, San Ramón, San Javier, Concepción e San Juan de Lomerio, as briefly characterized below:

AF – 85 (Águas Frias – Casa de Piedra intrusive suite): Granitic, pink gneiss;
CS – 84: (Cachuela Soares – Casa de Piedra intrusive suite): Foliated, biotite granitic gneiss;
SR – 83: (Santa Rosa – Refúgio): Massive granite;
LM – 81: (Estância Las Maras): Coarse grained massive granite.

METODOLOGY

The selected crystals (under binocular loupe; 88 to 212 X) were the most abundant and clear ones in a given concentrate. The preferred zircons showed similar proportions, and each fraction had usually weight of 30 μg. In brief, the U-Pb TIMS chemical routine (Dilution Thermal Ionization Mass Spectrometry) used at the CPGeo involves previous HCL (6N) and HNO_3 (7N) washing of zircons in Savillex vials order to reduce the adsorbed ^{204}Pb from the rims and fractures (Sato et al., 2003, 2008; Passarelli et al., 2009). This stage is succeeded by chemical dissolution of the zircons in Teflon microcapsules using ^{205}Pb and ^{235}U spikes and high purity HF and HNO_3 acids (3:1 proportion), within steel jackets. The total ^{204}Pb blank of such a U-Pb chemistry is 10 pg.

In this way, alternative techniques reported in the literature were applied for zircons from the Bolivian granitoid rocks, combining: *i*) hand-picking of D-type zircons (and related subtypes when necessary: P5, S25, J5; minimum temperatures of about 850°C), as described

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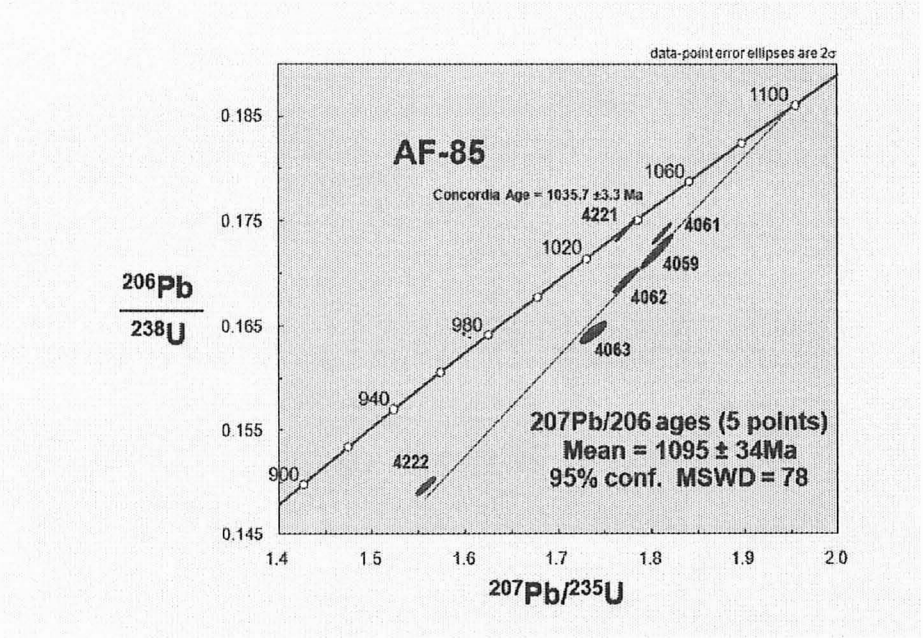
According to Pupin (1976), the face types are related to the chemical composition and crystallization temperatures. The ideal crystal (pyramidal D-type) is the highest temperature one (≥900ºC) from highly evolved granitic magmas. By applying the U-Pb TIMS technique they provide well-defined upper intercept ages, related therefore the time of crystallization of a given rock. On the other hand, the air abrasion technique (Krogh et al., 1982a, b) creates a more concordant U-Pb system by removing outer crystal layers, as well as high-U parts that usually are subjected to radiation damage. Altered and cracked zircons also tend to be eliminated.

RESULTS

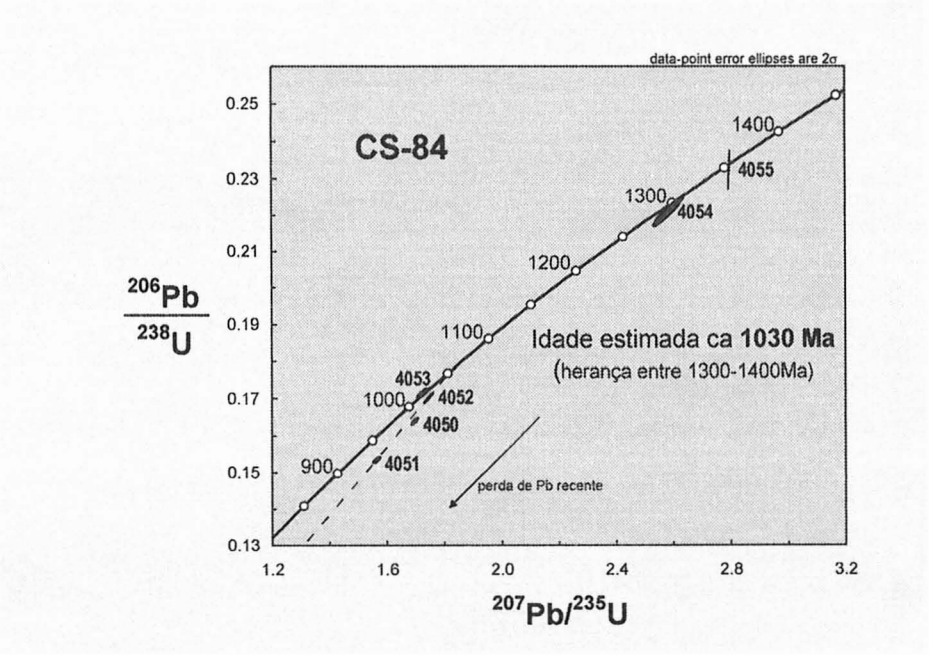
Figure 1



Fractions 4059, 4061, 4062 e 4063 from granitic gneiss AF-85 (routine described by Passarelli et al., 2009), yielded an upper intercept age of 1089 ±14 Ma by using the forced discordia model of Ludwig (2003). Two additional fractions (using Pupin' types) were also analyzed, one of them (4221) yielding a concordant age of 1035,7 ± 3,3 Ma, interpreted as the time of rock crystallization. The other fraction (4222) is strongly discordant, but together with the previous fractions determines an upper intercept age of 1095 ± 34 Ma which signals a minimal age for the protholith.

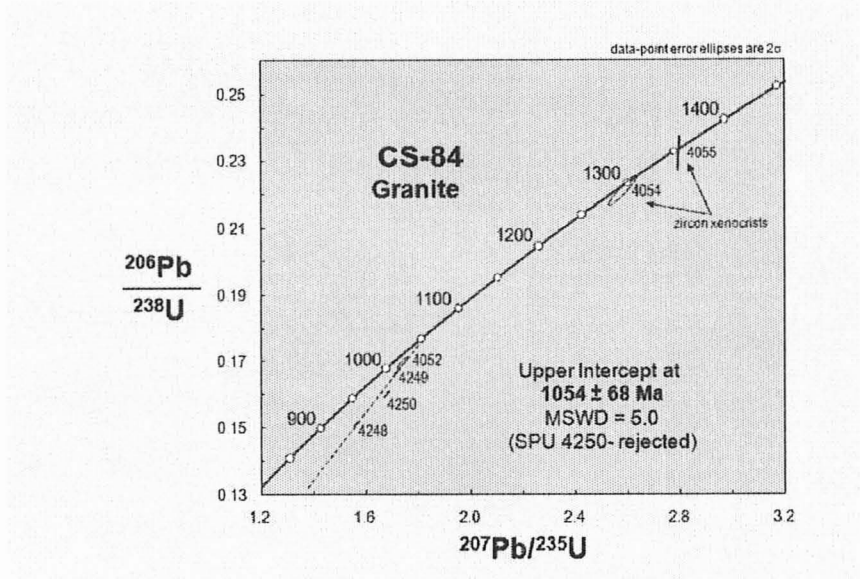
CS-84 sample showed a complex isotopic systematics (figure 2). The preliminary analyzed fractions determined a polycyclic, but dubious history: fractions 4054 and 4055 suggest Pb-inheritance from source-materials as old as 1300 and 1400 Ma. The four other fractions (4050, 4051, 4052, 4053) characterize a much youngest age of 1059 ± 25 Ma (not shown). Fraction 4051 showed the lowest $^{206}Pb/^{204}Pb$ ratios among the samples, and therefore was excluded for the age calculation. Fraction 4053 gives a concordant age of 1017 ±6 Ma (2σ) – not shown.

Figure 2



Three additional zircon fractions were hand-picked in accordance with the Pupin's method (4248, 4249, 4250) which, together with fraction 4052, determine an upper intercept discordia age of 1054 ± 68 Ma (MSWD=5.0) (figure 3). ICPMS-LA analyses supported by cathodoluminesce imagery for the zircon types shall provide a more detailed picture of the rock evolution.

Figure 3



FINAL REMARKS

U-Pb TIMS zircon geochronology of granitoid rocks has showed the complexity of the isotopic systematics of granitoid rocks. Air abrasion technique (Krogh, 1982) combined by Pupin's zircon typology are potentially useful for improving U-Pb age calculations and more concordant fractions. Additional cathodoluminescence studies and Laser Ablation datings are crucial when the analized zircons have polycyclic characteristics, as previously detected by the U-Pb TIMS in gneiss CS-84.

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