GEOCHRONOLOGY OF CERNE GRANITE (APIAÍ FOLDED BELT, SOUTHEAST BRAZIL) – INTERPRETATION OF DISCORDANT U-Pb ZIRCON AGE

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Keywords: U-Pb (zircon), discordant ages, late to pos-orogenic granites

The Apiaí Folded Belt (as defined by Hasui et al., 1975) configures an extensive NE-SW oriented domain, located in the eastern of Paraná State (Southeastern Brazil). It is constituted by meso to supracrustal rocks, deformed and metamorphosed at greenschist to amphibolite facies, intruded by Paleoproterozoic and Neoproterozoic granitic batholiths and stocks.

The Cerne Granite (Fig. 1) covers an area of approximately 45 km^2, being recognized like one of most expressive granitic intrusions of Apiaí Folded Belt. It is constituted mainly by syenogranites with microcline, quartz, plagioclase An $_{7-10}$, green biotite, Ca-amphibole and opaque (magnetite, ilmenite and pyrite). The accessory phases are represented by sphene, apatite, fluorite, zircon and allanite. Others terms like monzogranites and quartz-syenites are subordinated. Those rocks show a medium to coarse inequigranular texture, characterized by megacrystals of microcline (up to 2cm), with solid to slightly magmatic flow structures. Other feature often recognized in the intrusion is microcrystalline mafic enclaves with syenitic composition, in spherical forms and centimeter sizes. In the granite border areas a restricted deformation is expressed by protomylonitic to mylonitic structures, always in small narrows (metric scale) between the contacts of the intrusion with the surrounding rocks.

According to Prazeres Filho (2000), the Cerne Granite represents an alkaline magmatism phase (shoshonitic character), late to pos-orogenic in relation to the Neoproterozoic Três Córregos-Cunhaporanga magmatic arc.

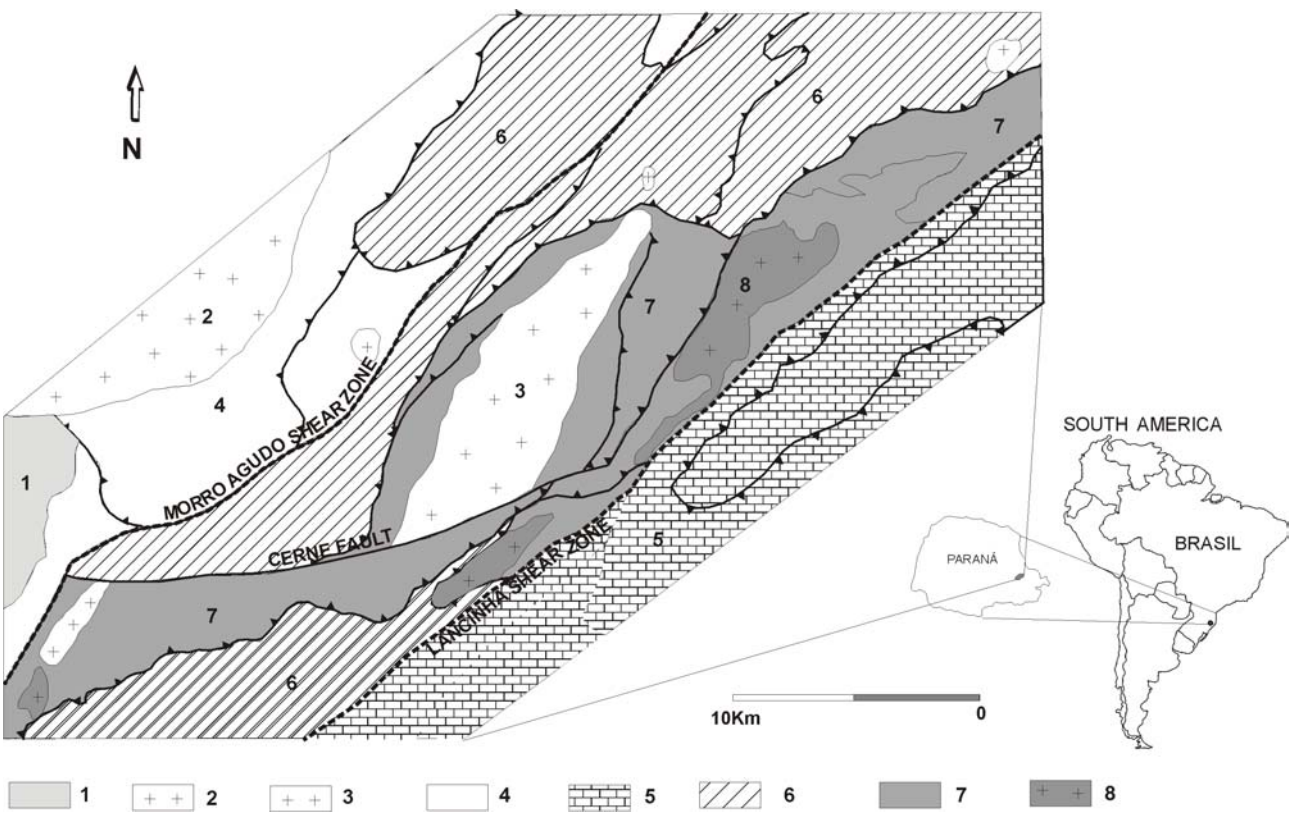

Figure 1. Geological sketch of Apiaí Folded Belt southern portion. (1) Camarinha Formation; (2) Três Córregos Granitic Batholith; (3) Cerne Granite; (4) Água Clara Formation; (5) Capirú Formation; (6) Votuverava Formation; (7) Betara Formation; (8) Alcaline Deformed Granitoids.

The intrusion shows an ellipsoidal form, elongated according to the regional structural trend (NE-SW). The contact areas between granite ad surrounding rocks are often made by high angle shear zones (75-90^o) and unusually show evidences of thermal metamorphism. The granitic body is located in antiformal folds originated by the displacement of dextral faults and adjacent shear zones (Lancinha Shear Zone, Morro Agudo Shear Zone and Cerne Fault). Fiori (1990, 1993) suggests that Cerne Grantie was contemporaneous to the development of the shear zones in ductile conditions, through a process of simple shear acquiring the present ellipsoidal form.

We documented geochronological dates of Cerne Granite by integrated U-Pb (zircon) conventional, Pb-Pb (zircon) evaporation, Ar-Ar (biotite) and Sm-Nd (whole rock) methods, accomplished in three samples from the different facies of the intrusion. The samples represent the granite with microcrystalline enclaves (CER-15), the isotropic sienogranite (CER-16) and the monzogranite (CER-23). The three samples seemingly contain the same zircon types. This typology study of the zircons was accomplished with the aid of cathode luminescence images.

The U-Pb (zircon) conventional ages obtained in the Cerne Granite are characterized by the great discordance of zircon fractions and, consequently, by the high error. The Concordia Diagram (Fig. 2) to the three samples of the Cerne Granite defines lower intercept age about of 563±34Ma and upper intercept age about of 2518±150Ma. The lower intercept age is interpreted as Cerne Granite crystallization age, supported by Ar-Ar (biotite) age about of 557±2Ma (CER-16 sample). The upper intercept age seems to be geological meaningless.

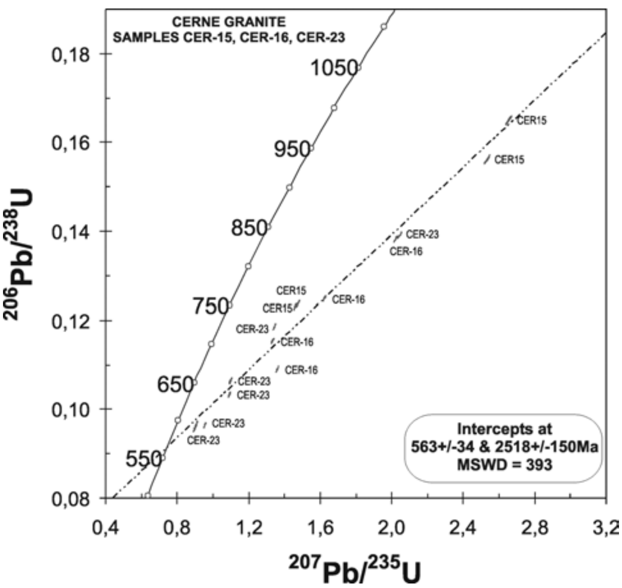

Figure 2. Concordia Diagram for samples of the Cerne Granite.

The most frequent zircons (type 1) are prismatic transparent crystals with few inclusions and weight between 0.1 and 1µg, showing length - width proportion between 2:1 and 4:1 (Fig. 4). The cathode luminescence images (Fig. 3) allow recognized sub-types of this zircon population, showing crystals with igneous zoning, crystals without zoning and some times with presence of rims and cores. The igneous zoning is defined by relatively thick strips or by sector zoning. Some crystals show a metamitic aspect. The presence of cores in some crystals, as well as the radiometric pattern U-Pb, suggest isotopic inheritance.

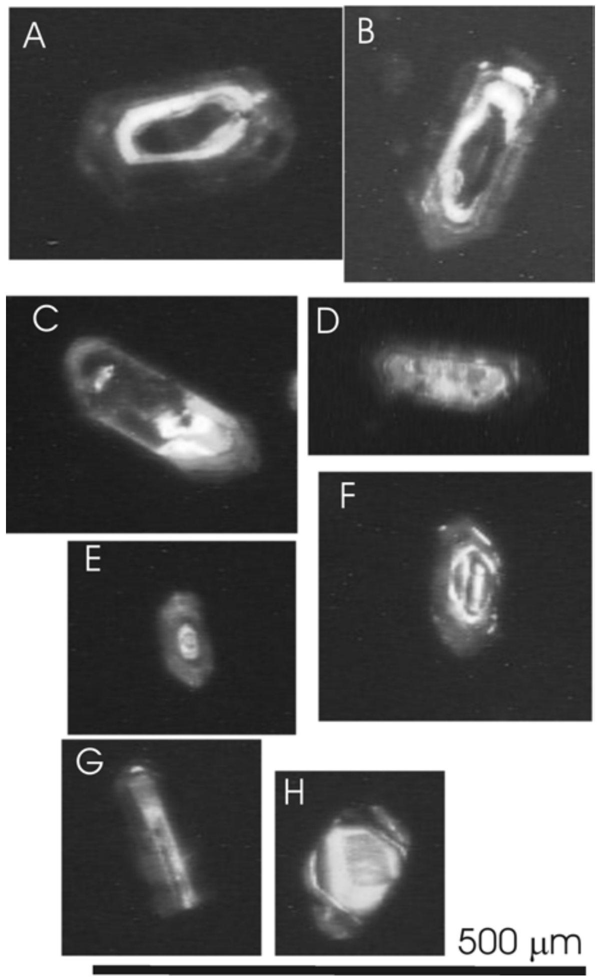

Figure 3. Cathode luminescence images. (A, B) crystals with 'irregular' core; (C, D) zircons perturbed; (E, F) concentric 'regular' cores; (G, H) "igneous" zoning sector.

The second zircon population of in the Cerne Granite samples (type 2) is characterized by larger prismatic translucent crystals (between 1 and 2 µg), balloon form, with length: width rate between 2:1 and 1:1 (Fig. 4).

The two different zircon types mentioned were analyzed by the ^{207}Pb-^{206}Pb by step and heat evaporation method -EVTIMS (Evaporation Thermal Ionisation Mass Spectometry). The two zircon types showed different isotopic rations defining different ages (Fig. 5). The type 1 zircon presents a plateau around 600 Ma, quite imprecise due to low amount of lead, with low detection in the spectrometer ion counter. The type 2 zircon presents a little more accurate plateau around 2.2 Ga, without evidences of Neoproterozoic ages.

Therefore the Cerne Granite zircon is characterized by the presence of crystals formed during Neoproterozoic, as well as crystals with significant Paleoproterozoic inheritance. Such inheritance seems to be associated with possible granite sources. However, part of this population with inheritance can be represent by captured zircons during the emplacement of the body. This idea is supported by Sm-Nd model ages about 2.1 Ga (CER-16 sample) very close, or even younger than ages ^{207}Pb-^{206}Pb of type 2 zircons.

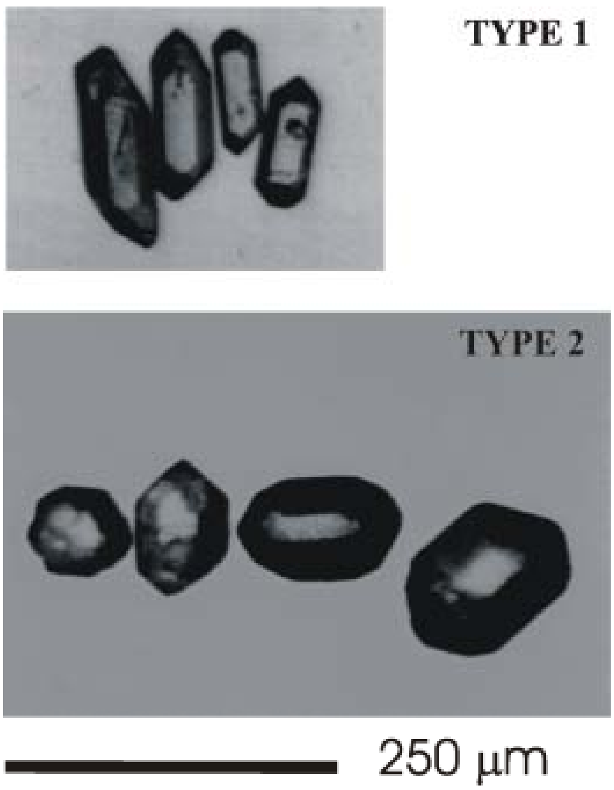

Figure 4. Images of transmitted light of zircon. Crystals from types 1 and 2.

The Cerne Granite geochronological scenario shows a great complexity expressed by discordance of zircon fractions and high error ages, explained here by presence of different zircon types. Techniques of high precision (like SHRIMP and LA-ICPMS) are necessary as well new cathode luminescence studies for a better understanding of the zircon morphology.

The Cerne Granite crystallization age about of 563±34Ma (U-Pb, lower intercept) supported by the granite cooling age about 557±2Ma (Ar-Ar on biotite) is assumid here. Such age is quite similar to ages obtained in the Morro Grande and Serra do Carambeí granites (Prazeres Filho, in the press), which characterizes a latter to pos-orogenic magmatic episode in relation to the Três Córregos – Cunhaporanga magmatic arc.

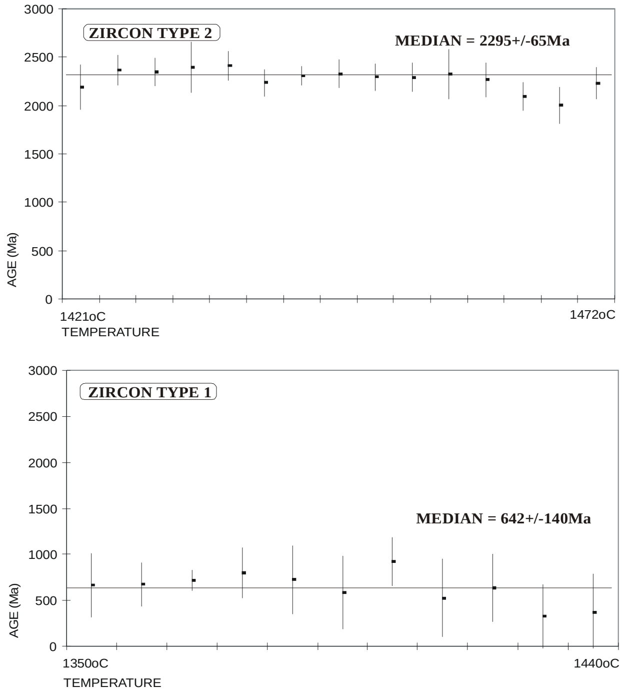

Figure 5. Pb-Pb graphics – evaporation of single grain of the two zircon types.

ACKNOWLEDGMENTS

The authors would like to thank the support from FAPESP (process n°. 01/00961-3) and to CPGeo-IGc-USP that made available the accomplishment of this work.

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