THE FÉ GRANITIC GNEISS, IN THE CENTRAL PART OF THE PALEOPROTEROZOIC MINEIRO BELT, SW SÃO FRANCISCO CRATON: U-Pb GEOCHRONOLOGY, Sm-Nd ISOTOPIC GEOCHEMISTRY AND TECTONIC IMPLICATIONS

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Key words: Fé granitic gneiss, U-Pb geochronology, isotopic geochemistry, Mineiro belt, São Francisco Craton.

INTRODUCTION AND REGIONAL GEOLOGY

The geological framework of the southern border of the São Francisco Craton comprises Archean and Proterozoic units of varied age and nature, which are now exposed side by side in response to multiple magmatic, tectonic and erosional processes (Fig. 1). Such a framework can be summarized as follows: *i*) an Archean crust composed mainly of granulites and partly migmatized gneisses (Campo Belo, Bonfim and Belo Horizonte complexes) and greenstone belt remnants (e.g., Rio das Velhas Supergroup in the Quadrilátero Ferrífero region) - further intruded by Archean felsic plutons; *ii)* a Paleoproterozoic domain occurring along the southern edge of the craton, containing greenstone belts, as well as voluminous mafic and felsic plutonic intrusions; and *iii)* Proterozoic supracrustal sequences of different ages (Minas Supergroup, and São João del Rei, Carandaí and Andrelândia megasequences) – e.g., Ávila et al., 2006.

The Paleoproterozoic plutons constitute most of the Proterozoic domain and are genetically associated with the pre-, syn- and late-tectonic stages of the Mineiro magmatic belt (Ávila 2000, Teixeira et al. 2000). In addition, these plutons exhibit Nd-Sr isotopic characteristics and calc-alkaline affinities that are compatible with products evolved from accretionary arc settings (e.g., Noce et al. 2000, Quéméneur and Noce 2000; Teixeira et al. 2005).

Recent geological mapping carried out in the central part of the Mineiro belt between Lavras and Conselheiro Lafaiete regions (Fig. 1) has shown that the mafic and ultramafic rocks can be assigned to two separated metavolcano-sedimentary units - the Nazareno and Rio das Mortes belts (e.g., Ávila et al. 2004). The mafic and ultramafic rocks of both belts were overprinted by two successive deformational and metamorphic events. The first one reached low- to medium grade amphibolite facies, whereas the second developed under greenschist- to low- amphibolite facies. The latter episode also overprinted the neighboring mafic and felsic plutons of the Mineiro belt (Ávila 2000).

The present work deals with the magmatic evolution of the Fé granitic gneiss, one of the plutons that crop out in the central part of the Mineiro belt. New U-Pb data and isotopic and chemical studies are presented providing insights on the tectonic evolution of this belt.

FÉ GRANITIC GNEISS – GEOLOGY AND PETROGRAPHY

The Fé granitic gneiss occurs between Ritápolis and Coronel Xavier Chaves, underlying an area of 12 km^2 (Fig. 1), emplaced into banded gneisses end migmatites. This elongated body shows a NNE/SSW trending foliation, and is overprinted in the south by Lenheiros shear zone. The body, as well as the nearby coeval intrusions (Brumado and Rio Grande diorites), displays amphibolite and pyroxenite xenoliths that resemble, respectively, the typical lithologies of the Rio das Mortes greenstone belt and the pyroxenitic-gabbroic bodies that crop out in the vicinities (Ávila et al. 1999).

In addition, pegmatitic injections cut randomly the Fé granitic gneiss as well as the adjacent bodies (e.g., Glória quartz-monzodiorite, Avila et al., 2006). These injections are coeval with the Ritápolis granitoid (2121 ± 7 Ma - Ávila 2000), that crops out extensively in the northwest part of the studied area.

The Fé granitic gneiss specimens show usually felsic and mafic bands; the modal composition is characteristic of monzogranitic and sienogranitic terms. The main mineralogical assemblage is: Quartz, K-feldspar, plagioclase, biotite, epidote, titanite and allanite. The primary texture is dominantly equigranular and subordinated porphyritic with K-feldspar megacrysts.

WHOLE ROCK GEOCHEMISTRY

Whole rock major and trace elements in six selected samples of the Fé pluton were carried out at the Geosciences Institute of the University of São Paulo, Brazil. The resulting, main chemical characteristics indicate predominantly a peralumious and subordinately metaluminous composition (Fig. 2a), a sub-alkaline trend

(Fig. 2b), and a calc-alkaline tendency (Fig. 2c), with high K contents (3% to 5.17%).

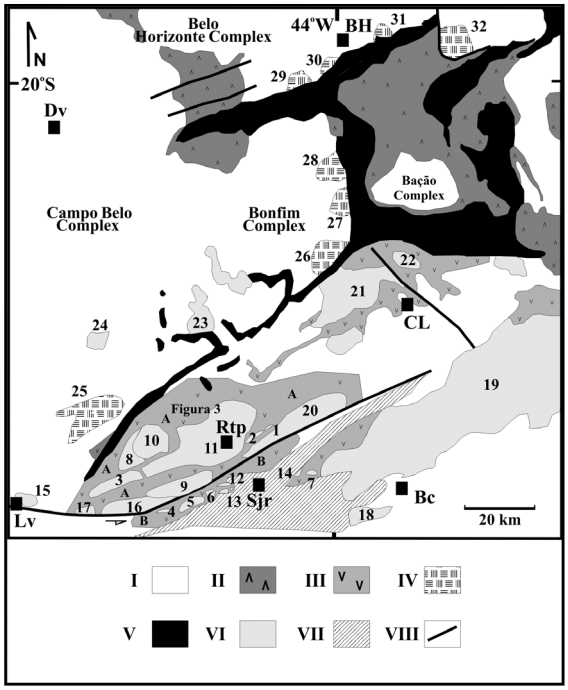

Figure 1 – Archean and Paleoproterozoic plutons in the southern São Francisco Craton (adapted from Ávila et al. 2003). I – Archean crust partly reworked during Paleoproterozoic times. II – Archean Rio das Velhas greenstone belt. III - Rio das Mortes (A) and Nazareno (B) greenstone belts. IV – Archean granitoids. V – Paleoproterozoic felsic and mafic plutons. VI – Minas Supergroup (Paleoproterozoic). VII –São João del Rei (Paleoproterozoic), Carandaí (Mesoproterozoic) and Andrelândia (Neoproterozoic) supracrustal sequences. VIII – Major structures. Paleoproterozoic plutons: 1 – Glória quartz-monzodiorite; 2 – Brumado diorite; 3 - Rio Grande diorite; 4 - Rio Grande gabbro; 5 - São Sebastião da Vitória gabbro; 6 – Brito quartz-diorite; 7 - Vitoriano Veloso gabbro; 8 – Ibituruna diorite; 9 – Cassiterita tonalite/trondhjemite; 10 – Tabuões trondhjemite; 11 – Ritápolis granitoid; 12 - Brumado de Baixo granodiorite; 13 - Brumado de Cima granodiorite and granophyric bodies; 14 – Tiradentes granitoid; 15 – Nazareno granite; 16 – Itumirim granitoid; 17 – Congonhas tonalite; 18 – Campolide granite; 19 – Ressaquinha complex; 20 – Fé granitic gneiss; 21 - Alto Maranhão tonalite. *Archean plutons*: 22 – Caeté granodiorite; 23 - General Carneiro granite; 24 - Morro da Pedra granite; 25 - Ibirité granodiorite; 26 - Samambaia tonalite; 27 – Mamona granodiorite; 28 - Salto do Paraopeba granite; 29 – Bom Sucesso granite.

The samples show large variation in SiO_2 content (from 72.47% to 78.04%). The samples are characterized by prominent enrichment of LREE with $(La/Yb)_n$ between 23.81 and 37.45, and strong negative Eu anomalies (Fig. 3b). Data plotted in a spidergram (Fig. 3a) suggest a volcanic arc signature, given by the Sr and Ti negative anomalies. Positive Zr and negative P anomalies (0.025% to 0.06%) are observed and may be interpreted as inheritance from the magma, as suggested also by the relationships between Rb vs (Y+Nb) (Fig. 2d), which is characteristic of magmatic arc rocks. However, two of the studied samples plot in the WPG field.

The present work deals with the magmatic evolution of the Fé granitic gneiss, one of the plutons that crop out in the central part of the Mineiro belt. New U-Pb data and isotopic and chemical studies are presented providing insights on the tectonic evolution of this belt.

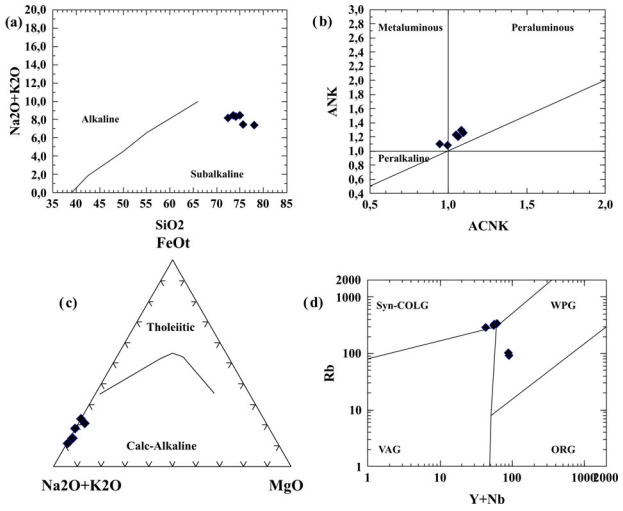

Figure 2 – (a) SiO_2 x Na_2O + K_20 (Irvine & Baragar, 1971); (b) Maniar & Picolli (1989) diagram ANK x ACNK; (c) AFM discrimination diagram; (d) Rb x (Y + Nb) discrimination diagram (Pearce et al. 1984), for selected samples of the Fé granitic gneiss.

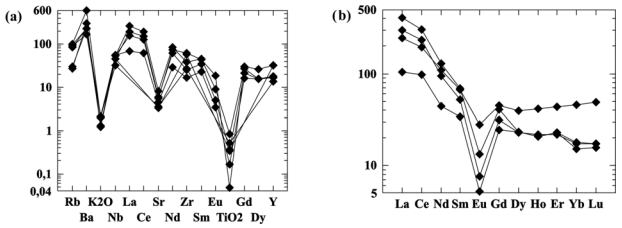

Figure 3 – (a) Primitive mantle-normalized incompatible elements spidergram; (b) Chondrite-nornalized REE patterns, for selected samples of the Fé granitic gneiss.

U-Pb AND Sm-ND ISOTOPES

Two zircon populations are present in the Fé granitic gneiss, one of them presenting 2 subtypes. Up to now only the small, prismatic crystals from one of these populations were dated by the U-Pb method TIMS in the CPGeo-USP (Geochronological Research Center of the University of São Paulo, Brazil).

This subtype of zircons exhibits well-developed bitermination, is colorless and contains frequent inclusions. Four fractions were separated (LC-01B A; LC-01B B; LC-01B C; LC-01B G) for spectrometry. The second subtype present short and small prismatic zircons, with well-developed bitermination, and is colorless and show similarly frequent inclusions. In this population 4 parts had been separated (LC-01B D; LC-01B E; LC-01B F; LC-01B H) for spectrometry. Of the total of nine

analyses, two were excluded for the age calculation (Ludwig, 2000) due to the very low radiogenic Pb. Of the selected analyses, five plot next to Concordia/Discordia intercept (Figure 12), and the obtained age is 2191.2 ± 8.6 Ma (MSDW=7.1, 2δ). This age is interpreted as of the crystallization of the Fé pluton.

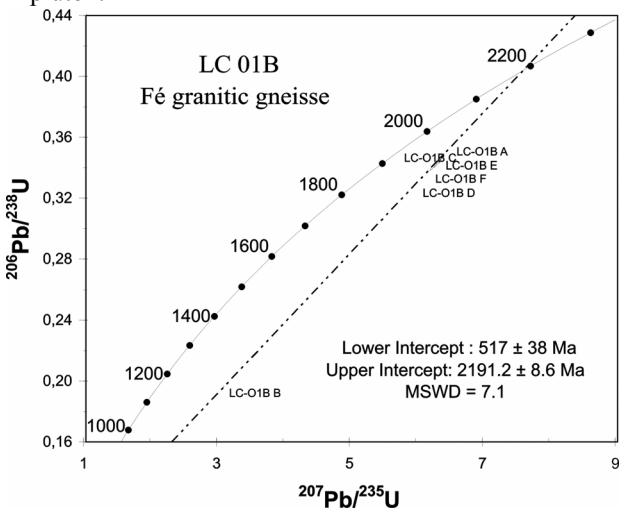

Figure 4 – U-Pb diagram of sample LC-01B of the Fé granitic gneisse. See text for details.

One Sm-Nd whole rock analysis (CAWT-01 A22) was also performed. This sample shows *f*Sm/Nd value (-0.44) compatible with crustal parameters for Nd fractionation. The calculated Sm-Nd T_{DM} (single) model age is 2.67 Ga, showing negative $\varepsilon_{Nd(2.190)} = -3.08$.

As such, the Nd evidence suggests that Archean components may have participated in the magma genesis of the Fé pluton.

SUMMARY AND FINAL REMARKS

The Fé granitic gneiss shows peralumious composition and a sub-alkaline trend. Data plotted in a spidergram and the relationships between Rb vs (Y+Nb) are characteristic of magmatic arc rocks.

The isotopic signatures are consistent with the characteristics and chemistry of "Group A" granitoids of the Mineiro Belt (Noce et al. 2000). According to this classification, "Group A" plutons (e.g. Porto Mendes, Ritápolis, Itutinga and Alto Jacarandá; see Figure 1) are dominantly peraluminous. They yield T_{DM} values between 2.6 - 2.8 Ga, show $\varepsilon_{Nd(T)}$ values between –11.0 a –3.8 and $^{87}Sr/^{86}Sr$ values between 0.7096-0.7584., would be formed from an Archean source. The Fé pluton is dominantly peraluminous as well, and show T_{DM} age of 2.67 Ga, and $\varepsilon_{Nd(T)} = -3.08$. Ávila et al. (2006) has also reported a similar Nd isotopic signature for other sample of the Fé pluton

The age of 2.191 ± 9 Ma and geochemical evidences together with the calc-alkaline characteristics of the Fé pluton, indicate its genetic association with nearby pre-collisional plutons of the Mineiro belt, such as the Glória quartz-monzodiorite (2188 ± 29 Ma) and the São Sebastião da Vitória gabbro (2220 ± 3 Ma) - (Ávila et al. 2006; Cherman 2004).

Finally, additional insights on the isotopic geochemistry and tectonic nature of the Fé granitic gneiss depends on data (Sm/Nd and Rb/Sr), currently in progress. In this way the preliminary inferences presented here will be tested with more solid recital.

ACKNOWLEDGMENTS

The authors express special thanks to FAPESP (Fundação de Amparo e Apoio à Pesquisa do Estado de São paulo) for the grant that supported this study (2004/1529-7 and 2004/11059-7). The authors acknowledge the support received from the Geochronological Research Center of the University of São Paulo, Brazil.

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RESUMO

O gnaisse granítco Fé é tectonicamente associado à evolução Paleoproterozóica do Cinturão Mineiro – porção sudeste do Cráton São Francisco -, é intrusivo nos gnaisses bandados e migmatitos do Greenstone Belt Rio das Mortes. Esse pluton mostra uma foliação predominante NNE/SSW, e é delimitado ao sul pela zona de cisalhamento dos Lenheiros. A composição modal do pluton Fé é característica de termos monzograníticos a sienograníticos. Sua composição geoquímica é peraluminosa e possui um trend cálcio-alcalino de alto K, apresentando características de rochas de arco magmático. O pluton Fé possui idade de cristalização de 2191 ± 9 Ma. Os isótopos de Nd ($\varepsilon_{Nd(2.190)}$ = – 3,08; T_{DM} = 2,675 Ga) sugere que um componente Arqueano deve ter participado na gênese magmática deste corpo. O gnaisse granítico Fé possui uma assinatura consistente com os granitóides do "Grupo A" (Noce et al. 2000) e tudo indica que possui uma associação genética com a fase pré-colisional do Cinturão Mineiro.