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Magnetic fabrics and microstructures of the post-collisional aegirine–augite syenite Triunfo pluton, northeast Brazil

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Abstract—Anisotropy of magnetic susceptibility (AMS) and microstructures of the Neoproterozoic Triunfo alkaline pluton, situated in northeast Brazil, have been investigated in order to characterize fabrics formed during its emplacement. Bulk magnetic susceptibility in the pluton varies between 0.15×10^{-3} and 25×10^{-3} SI, and the mean magnetic anisotropy ratio is around 1.04. Aegirine–augite and secondary magnetite are the main carriers of the magnetic susceptibility, with the former controlling the directions of the anisotropy. Magnetic foliation and lineation are consistently oriented throughout the pluton: foliation typically dips gently to the northeast and lineation plunges gently to the east. These structures were mostly acquired at the magmatic and sub-magmatic stages. The shape of the magnetic ellipsoid is dominantly oblate, a feature that may reflect either the uniaxial oblate AMS ellipsoid of the aegirine–augite crystals and/or a vertical compaction of the magma in its final stages of crystallization. The foliation pattern suggests the pluton has a tabular shape within the basement rocks. Magma emplacement is inferred to have occurred by its lateral migration along a flat-lying crustal structure after fracture propagation and ascension of the magma from a lower crust–mantle source. Late, fine-grained, vertical dykes with the same mineral composition as the Triunfo syenite cross-cut the wall rocks of the pluton and close the alkaline magmatism in the area. The NE-trending alignment of alkaline plutons and the NNE-trending syenitic dykes indicate that the emplacement of such bodies occurred along a crustal extension event with a minimum compressive stress horizontal trending roughly E–W. © 1997 Elsevier Science Ltd

INTRODUCTION

The origin of alkaline magmas during the evolution of a collisional orogen is a major subject of debate which has been recently focused on post-collisional granites (Sylvester, 1988). Their emplacement is associated with diffuse extensional and/or strike-slip shear regimes that follow collisional events by tens of millions of years (Liégeois and Black, 1987; Bonin, 1990). Field and isotopic data have shown that the Triunfo pluton, situated in the Cachoeirinha–Salgueiro belt (CSB) in northeast Brazil, is a post-collision body. This pluton constitutes the best-exposed and largest alkaline massif (600 km^2) of northeast Brazil. It belongs to a suite of syenites to alkali feldspar granites forming a 200 km-long corridor trending NE–SW (the 'syenitoid line' of Sial and Ferreira, 1988) in the eastern border of the CSB (Fig. 1). These plutons intrude both metamorphic rocks and an older magmatic suite of calc-alkaline granites, granodiorites and tonalites dated around 620–630 Ma (Mariano and Sial, 1988; Sial, 1993). The alkaline rocks form two groups: (i) silica-saturated ultrapotassic alkali feldspar syenites to alkali feldspar granites, which include the Triunfo pluton; and (ii) silica-oversaturated potassic alkali feldspar granites (Ferreira and Sial, 1986). A Rb/Sr whole-rock isochron gives 583 ± 12 Ma for the Triunfo syenite, which is considered to be the age of its emplacement (Ferreira *et al.*, 1994). The isotopic data suggest that the rocks of the syenitoid line were extracted from a Paleoproterozoic lithospheric mantle and show minor crustal contamination during ascent and emplacement in the continental crust (Ferreira *et al.*, 1994; Van Schmus *et al.*, 1995).

This paper describes the internal structure of a post-collisional alkaline pluton and discusses its mode of emplacement in a tectonic regime dominated by extensional and transcurrent movements. Emplacement-related fabrics are characterized by using the anisotropy of low-field magnetic susceptibility (AMS). The magnetic fabric, defined by the directions and magnitudes of the principal susceptibilities K_1 (magnetic lineation, where $K_1 \geq K_2 \geq K_3$) and K_3 (magnetic foliation), normally correspond to the strain axes of the magmatic fabric (Ellwood and Whitney, 1980; Bouchez *et al.*, 1990). In addition to the AMS investigation, we undertook a detailed microstructural study in order to characterize the origin of the mineral fabric, mainly by examining whether the fabric was frozen in a magmatic state or reworked in the solid state.

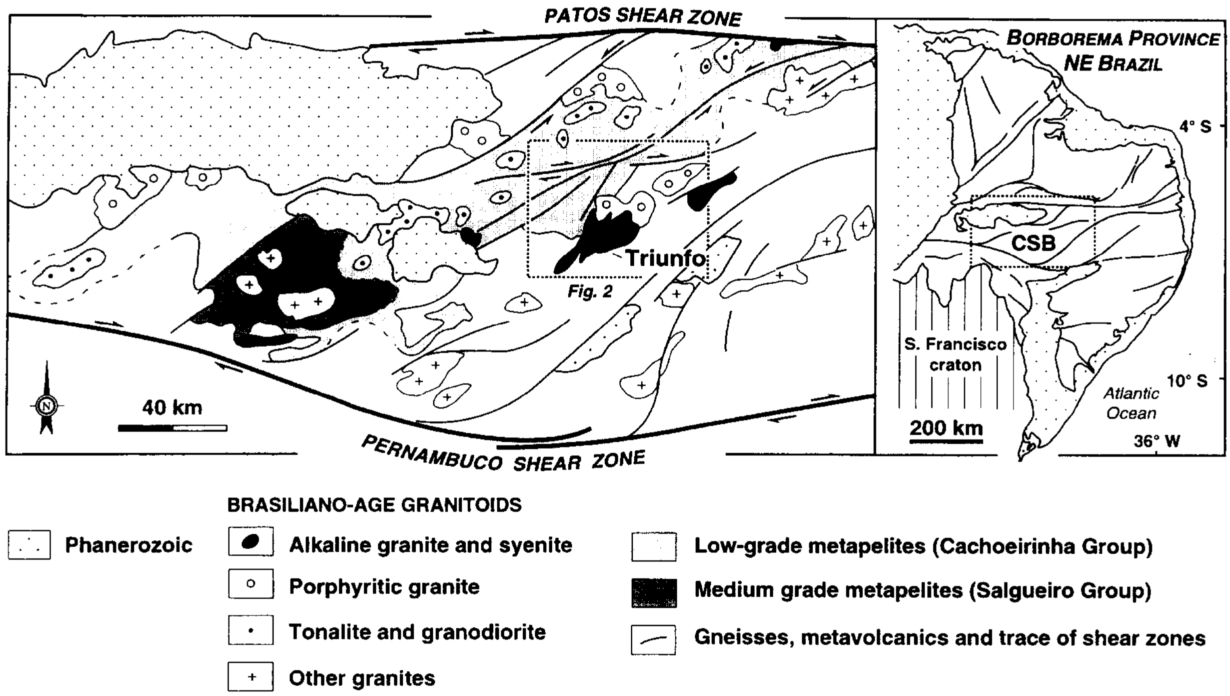

Fig. 1. The Cachoeirinha–Salgueiro belt (CSB) in the Borborema Province, northeast Brazil (modified from Ferreira *et al.*, 1994).

GEOLOGICAL SETTING

The syenitoid line intrudes the Meso- to Neoproterozoic units of the CSB, composed essentially of flysch-type sequences metamorphosed to greenschist facies (Cachoeirinha Group) and amphibolite facies (Salgueiro Group), and by gneissic basement rocks (Santos and Brito Neves, 1984; Van Schmus *et al.*, 1995). These units are bounded to the north and south by, respectively, E-trending, dextral Patos and Pernambuco shear zones (Fig. 1). The Triunfo pluton is almost entirely surrounded by Proterozoic migmatitic gneisses, except in the north where it intrudes the Princesa Isabel porphyritic granite (Fig. 2), and at its northwestern border where it is in fault contact with low-grade metapelites. An important swarm of fine-grained, decimetre- to metre-wide dykes of syenitic composition, bearing aegirine–augite microphenocrysts, surround the pluton. The foliation of the host schists and gneisses controlled the emplacement of these dykes. They have various orientations, but they strike mostly NNE–SSW. In the isotropic porphyritic granites situated northeastward the dykes strike N–S to NE–SW. Regionally, these dykes do not occur to the north of the E-trending Juru shear zone and, elsewhere, they intrude every formation of the CSB. In one outcrop on the southern border of the Triunfo syenite one of these dykes cross-cuts the pluton. Therefore, the same tectono-magmatic event seems to be responsible for the settling of the pluton and for the subsequent injection of the syenitic dykes.

In the basement rocks the regional foliation strikes mostly NNE–SSW, with gentle dips except along the shear zones where the planar fabric becomes vertical. In the shear zones the foliation carries a sub-horizontal stretching lineation and upper greenschist facies conditions are reached, with garnet and biotite mineral assemblages. Close to the pluton, our structural reconnaissance found stretching lineations with gentle plunges to the northeast and east (Fig. 2).

PETROGRAPHY AND MICROSTRUCTURES OF THE PLUTON

The syenite is composed of microcline (75–90%), aegirine–augite (10–25%) and some blue amphibole (<2%), displaying a medium- to fine-grained (2.5–0.3 mm) equigranular texture. Apatite and titanite are the principal accessory minerals. Aggregates of pyroxene crystals, forming ovoid to elongate rafts of dark material, sometimes show pinch-and-swell or boudinage structures that suggest a syn-plutonic emplacement in the form of dikes (Ferreira *et al.*, 1994). Medium- to coarse-grained pegmatitic veins bearing the same minerals as the host syenite (K-feldspar, aegirine–augite) locally cut the pluton.

Around the village of Santa Cruz, the syenite exhibits a porphyritic texture characterized by centimetric crystals of K-feldspar within a medium-grained matrix. The tabular feldspars define a foliation which, on average, strikes 164° and dips 37°NE; the alignment of phenocrysts form a lineation which, on average, plunges 26° toward 060°. In the southern part of the pluton, the syenite is fine-grained and no preferred orientation is

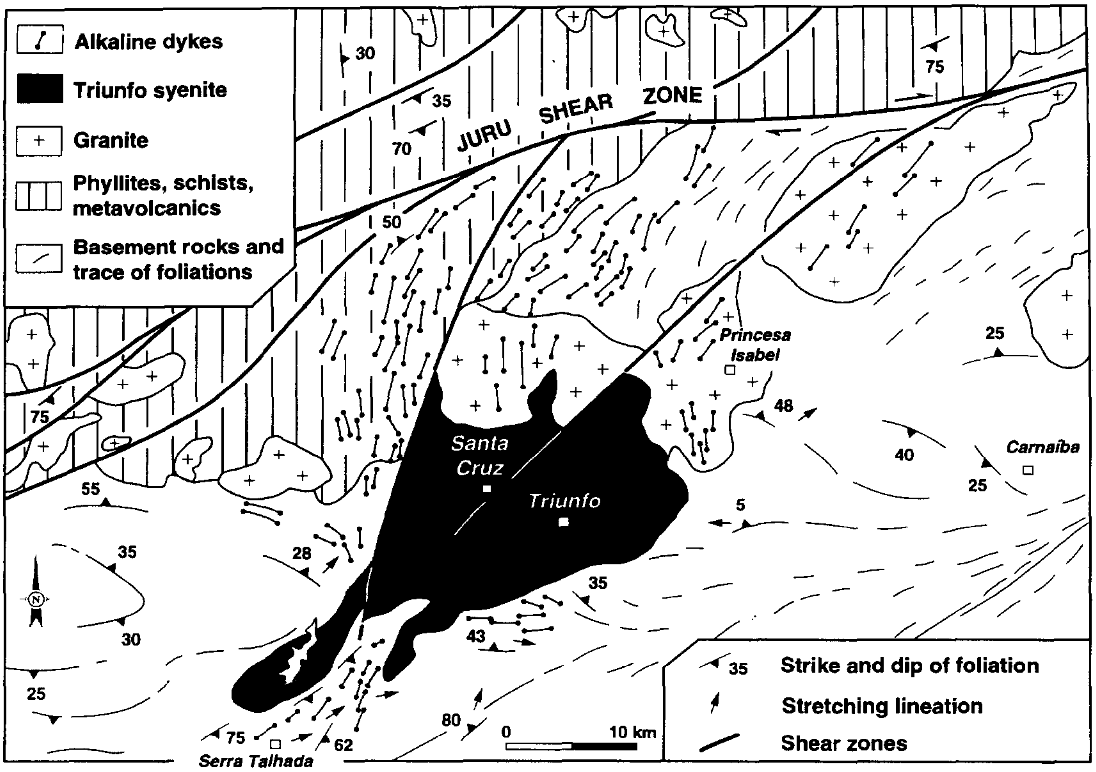

Fig. 2. Geological sketch map of the Triunfo pluton showing the swarm of syenitic dykes and main rock formations and structures (modified from Sato, 1987).

perceptible in the field. In contrast, in the east and northwest parts, the syenite has a medium grain size and a distinct fabric defined by the pyroxene grains. Finally, along the NE-trending fault zone that cross-cuts the pluton northeast of Santa Cruz, the texture is fine-grained, and some quartz and biotite are observed in thin section.

The microstructures were determined from thin sections prepared from samples from the 109 stations distributed throughout the pluton used for the magnetic fabric measurements. Magmatic to sub-magmatic, or primary, textures (Paterson *et al.*, 1989; Bouchez *et al.*, 1992) were distinguished from late to post-magmatic textures that developed after the full crystallization of the magma. Three types of microstructures were characterized (Fig. 3), and their distribution in map view is presented in Fig. 4.

(i) A magmatic to sub-magmatic microstructure (Fig. 3a) is restricted to the southwestern lobe of the pluton making less than 10% of the total. It is characterized by an equigranular arrangement of grains, with the K-feldspars showing typical cross-hatch microcline twinning, often associated with slight undulose extinction, and with amphibole and pyroxene crystals having well-developed crystal faces. The contacts between grains are straight to slightly bowed, sometimes with equilibrated triple junctions between microclines, or between microcline and pyroxene.

(ii) An incipiently recrystallized microstructure (Fig. 3b) occurs over most of the central part of the pluton. It is typified by small albitic neoblasts mantling the large grains of microcline. Where incipient, this recrystallization does not mask the straight contacts between microclines, or between microcline and pyroxene. Patches of albite or perthites, often aligned along the extinction bands, are commonly observed in microcline. Halos of discoloration are sometimes observed at the peripheries of pyroxenes, and often associated with secondary grains of magnetite and amphibole.

(iii) A recrystallized microstructure (Fig. 3c) occupies the eastern border, and also occurs in NE–SW elongate domains to the south and northwest of Santa Cruz. In this microstructure, albite neoblasts are ubiquitous along the microcline boundaries, albite patches within the microclines are common and strain-induced perthites usually underline microshear fractures. Pyroxene, transformed at its periphery into blue amphibole, is frequently associated with new grains of biotite, magnetite and epidote (Fig. 3d). Quartz grains are usually observed in association with albite and microcline.

MAGNETIC FABRIC

Sampling and working data

Two oriented cores, making four cylindrical samples, were collected at each of 109 stations (an average of

1.5 km apart) within the pluton. A total of 436 samples, 2.5 cm (diameter) × 2.2 cm (length), were prepared for magnetic measurement. The low-field (3.8×10^{-4} T; 920 Hz) anisotropy of magnetic susceptibility of each specimen was determined using a KLY-2 Kappabridge susceptometer (Agico; Brno, Czech Republic) with a sensitivity better than 10^{-7} SI. With this instrument a sequence of 15 susceptibility measurements along different orientations of the sample is used to compute the orientation and magnitude of the susceptibility ellipsoid, with principal axes $k_1 \geq k_2 \geq k_3$. The working data for each station ($j = 1, 4$) are therefore formed by the tensorial means of k_{ij} ($i = 1, 3$), giving the long axis K_1 of the station's AMS ellipsoid, or magnetic lineation, and the short axis K_3, or normal, to the magnetic foliation. These magnetic fabric orientations are very stable from one specimen to the next: the absolute directional variability of k_1 and k_3 in a given station is, respectively, less than 20° for 86% and 89% of the stations. Stations having the principal directions out of a cone of 25° about the tensor average form a total of nine for the orientations of k_1, and a total of four for k_3. Because the angular dispersion about the tensor averages is considered as too large, the corresponding K_1 and K_3 values have been discarded and are not represented in map views.

Low-field magnetic susceptibility properties

The bulk magnetic susceptibility magnitude, $K = 1/3(K_1 + K_2 + K_3)$, varies from 0.15×10^{-3} SI to 25×10^{-3} SI (Fig. 4). The two orders of magnitude variation of K is attributed to a significant variability in the magnetite content of the rock. The approximately 20% of the stations displaying 0.5×10^{-3} SI have virtually no magnetite; in fact, this value of K is the maximum paramagnetic susceptibility magnitude which can be calculated (see Rochette, 1987; Rochette *et al.*, 1992) given the iron content of the syenite. Specimen TR 28, whose susceptibility is $K = 0.48 \times 10^{-3}$ SI, is representative of this paramagnetic behaviour as exemplified by its low-field $K = f(T)$ variation which shows no indication of ferrimagnetic mineral species (Fig. 5a). Hence, the magnetic susceptibility of these samples is entirely carried by the paramagnetic minerals, mainly pyroxene. All the stations in the southwest lobe of the pluton, where the microstructure is typically magmatic, belong to this category, and some of them are dispersed in the central body.

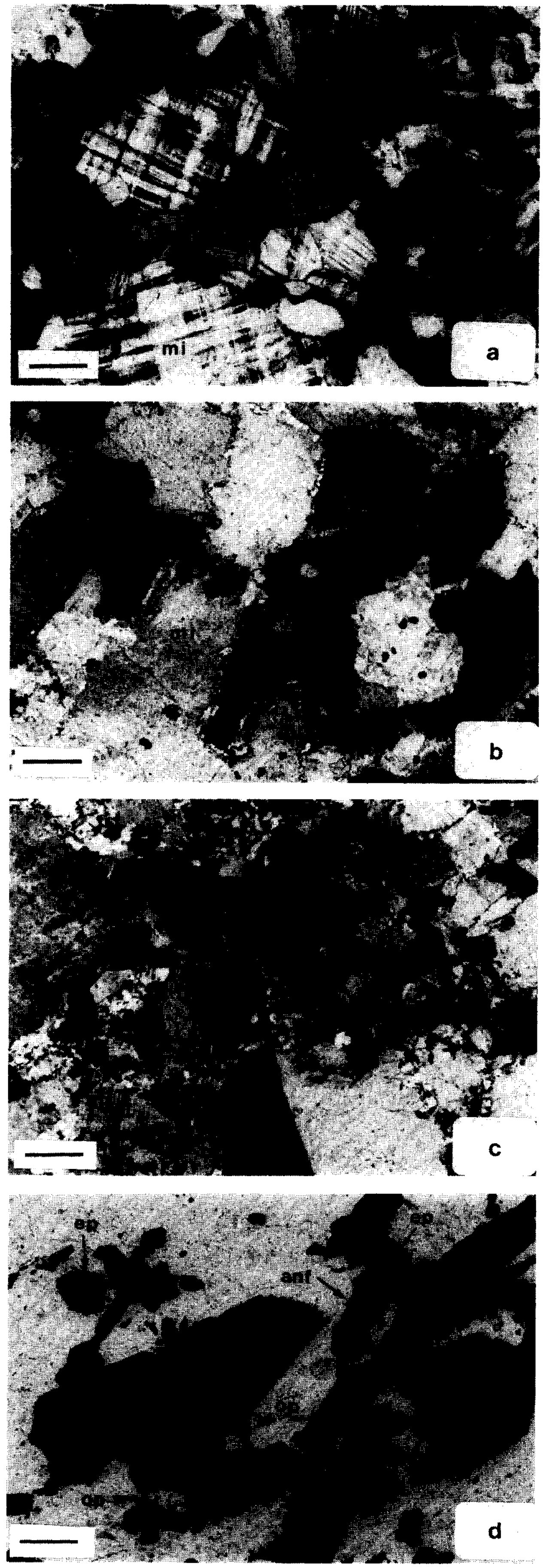

Fig. 3. Microstructures of the syenitic pluton of Triunfo: (a) magmatic; (b) incipient recrystallization. Note small albite grains along the boundaries of K-feldspars; (c) abundant new grains of albite and microcline around magmatic crystals of clinopyroxene (centre) and K-feldspar; and (d) opaque minerals formed along the periphery of aegirine–augite crystals in the strongly recrystallized syenite. mi, microcline; cpx, clinopyronexe; anf, amphibole; op, opaque grains; ap, apatite. Scale bars = 0.5 mm.

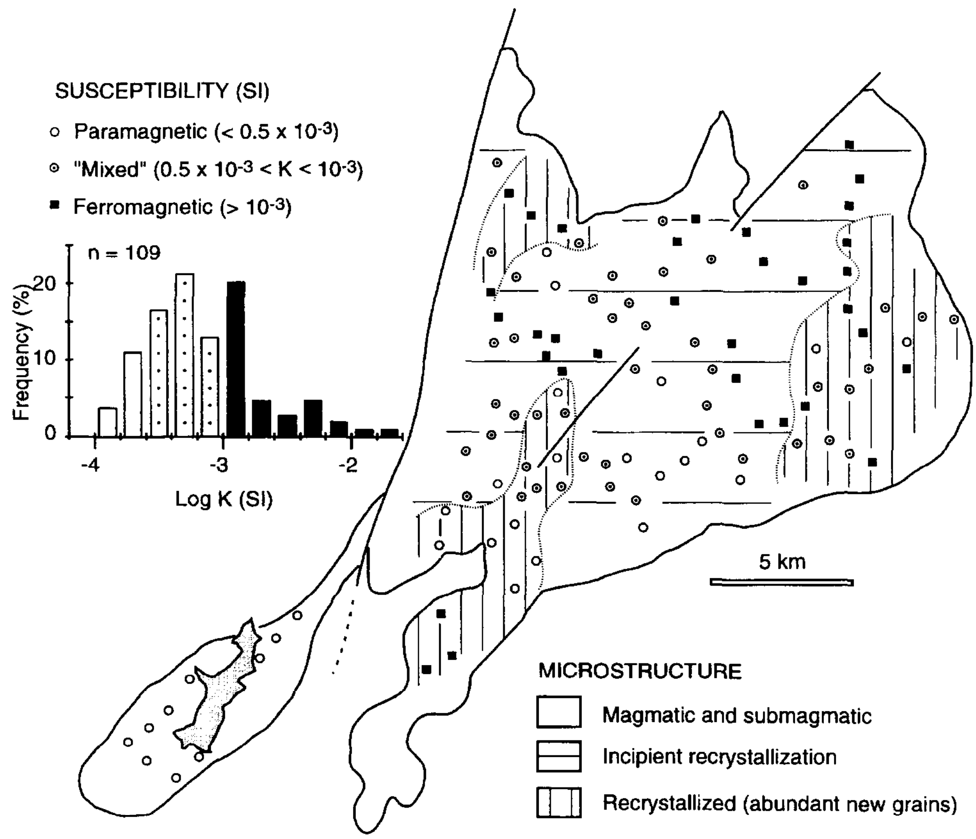

Fig. 4. Magnetic susceptibility and microstructures of the Triunfo pluton. Each point represents a station sampled for AMS.

The remaining 80% of the stations are either ferromagnetic ($K > 10^{-3}$ SI; 36% of the stations) or 'mixed' (0.5×10^{-3} SI $< 10^{-3}$ SI). Their distribution is heterogeneous and apparently unrelated to the amount of recrystallization (Fig. 4). In the 'mixed' samples the bulk magnetic susceptibility comes from the contributions of both the paramagnetic and ferromagnetic fractions. Specimens TR 56 and TR 105, with their constant $K = f(T)$ behaviour up to $T = 570°C$ and their abrupt susceptibility decrease down to $K \sim 0$ at higher temperatures (Fig. 5b & c), are typical of rocks containing Ti-poor magnetite.

Magnetic anisotropy and shape parameter

The total anisotropy is defined by the ratio between the maximum and minimum magnetic susceptibilities ($P = k_1/k_3$). Seventy-three per cent of the stations' P values are lower than 1.04, and a few of them are rather strongly anisotropic, larger than 1.10. A P vs K plot (Fig. 6) shows that, in the paramagnetic domain where P has a mean value of 1.02, P does not show any particular correlation with K. For higher K values, and typically those of the ferromagnetic domain, although there is some scattering P increases up to 1.20. This increase in P with K is primarily attributed to the increase of both the average shape ratio and the shape-preferred orientation of the grains of magnetite (see Discussion).

The shape of magnetic ellipsoid, here represented by the T parameter of Jelinek (1981), is dominated by oblate ellipsoids ($T > 0$) in 81% of the stations (Fig. 7). Plano-linear fabrics ($-0.25 < T < 0.25$) are mostly restricted to the southern border of the pluton and the strongest planar fabrics ($T > 0.25$) occupy the central, western and northern sectors. No particular correlation is observed between T and K (Fig. 7a), nor between T and P (Fig. 7b), or with the microstructural types. We believe that the oblate fabric is a primary feature achieved during the emplacement of the magma, but it may also be enhanced by the magnetic mineralogy which controls the AMS (see Discussion).

Directional data

The magnetic lineation (k_1) and foliation (normal to k_3) pattern is very regular throughout the pluton (Fig. 8). The lineations trend mainly ENE–WSW and have low plunges to the east-northeast (mean lineation azimuth = 0.83°, mean plunge = 14°E) and foliations usually dip smoothly to the northeast (mean foliation strike = 135°, mean dip = 14°NE). The foliations mostly strike NW–SE to E–W, nearly perpendicular to pluton

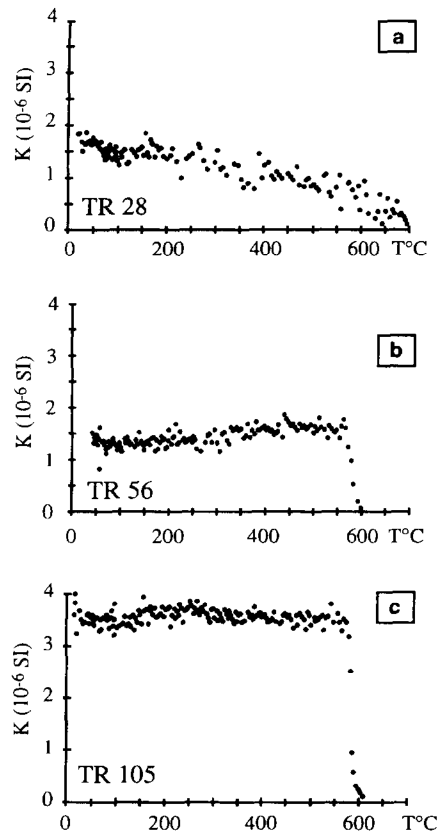

Fig. 5. Low-field bulk magnetic susceptibility (K) vs temperature plots from selected samples of the Triunfo pluton. Specimens TR56 (b) and TR105 (c) show blocking temperatures of around 570°C, typical of magnetite.

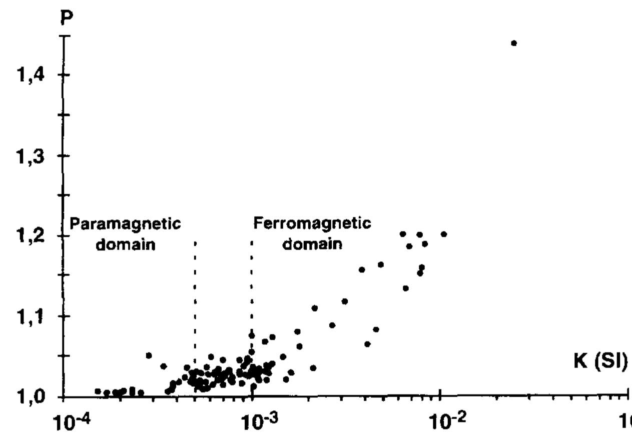

Fig. 6. Magnetic anisotropy (P) vs bulk susceptibility (K) plot. The paramagnetic domain ($K<0.5\times10^{-3}$ SI) and ferromagnetic domain ($K>10^{-3}$ SI) are labelled after Rochette (1987) and Rochette *et al.* (1992).

DISCUSSION

Magnetic fabric and magnetic mineralogy

elongation, and dip at moderate angles dominantly to the northeast. Along the western border foliations tend to dip more easterly. The microstructural type does not affect substantially the orientation of the magnetic fabric, except for a net increase of the scattering in the recrystallized domain (Fig. 9). However, lineations and foliations remain close to each other whatever the microstructural domain.

The most remarkable AMS feature in the Triunfo pluton is that the magnetic fabric does not vary appreciably with the susceptibility magnitude. In particular, in stations where the susceptibility is attributed to either paramagnetic minerals alone or to ferrimagnetic minerals, the magnetic lineation and foliation usually keep a common orientation. Such a behaviour of AMS principal directions from adjacent stations showing strong bulk susceptibility variations is illustrated in Fig. 10. We selected nine stations along an E–W-trending, 10 km-long traverse. Four stations (32–35) have low susceptibilities ($K<0.5\times10^{-3}$ SI) and two stations (15 and 38) have high susceptibilities ($K>10^{-3}$ SI). In the former stations, AMS is controlled by the magnetocrystalline anisotropy of aegirine–augite, the main Fe-bearing silicate of the syenite, whereas in the latter stations AMS is controlled by the shape anisotropy of

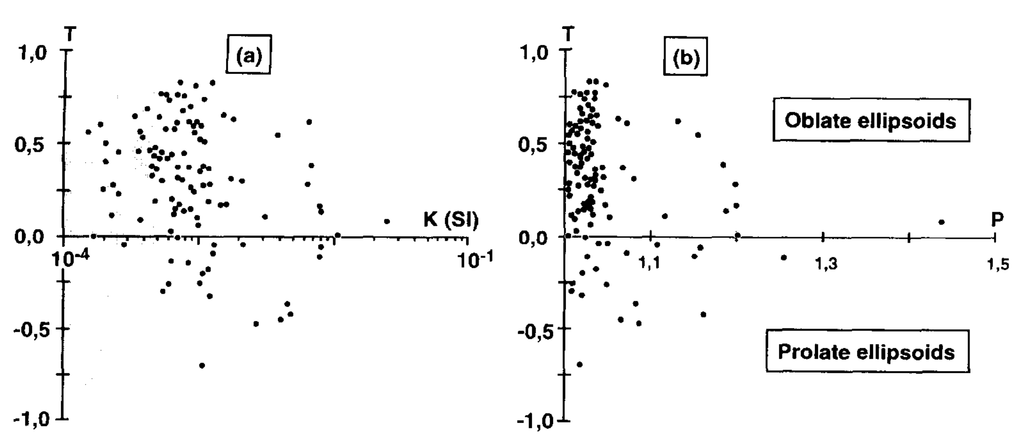

Fig. 7. Shape parameter (T) of the susceptibility ellipsoid vs (a) bulk susceptibility (K) and (b) anisotropy (P). Shaded area: paramagnetic domain.

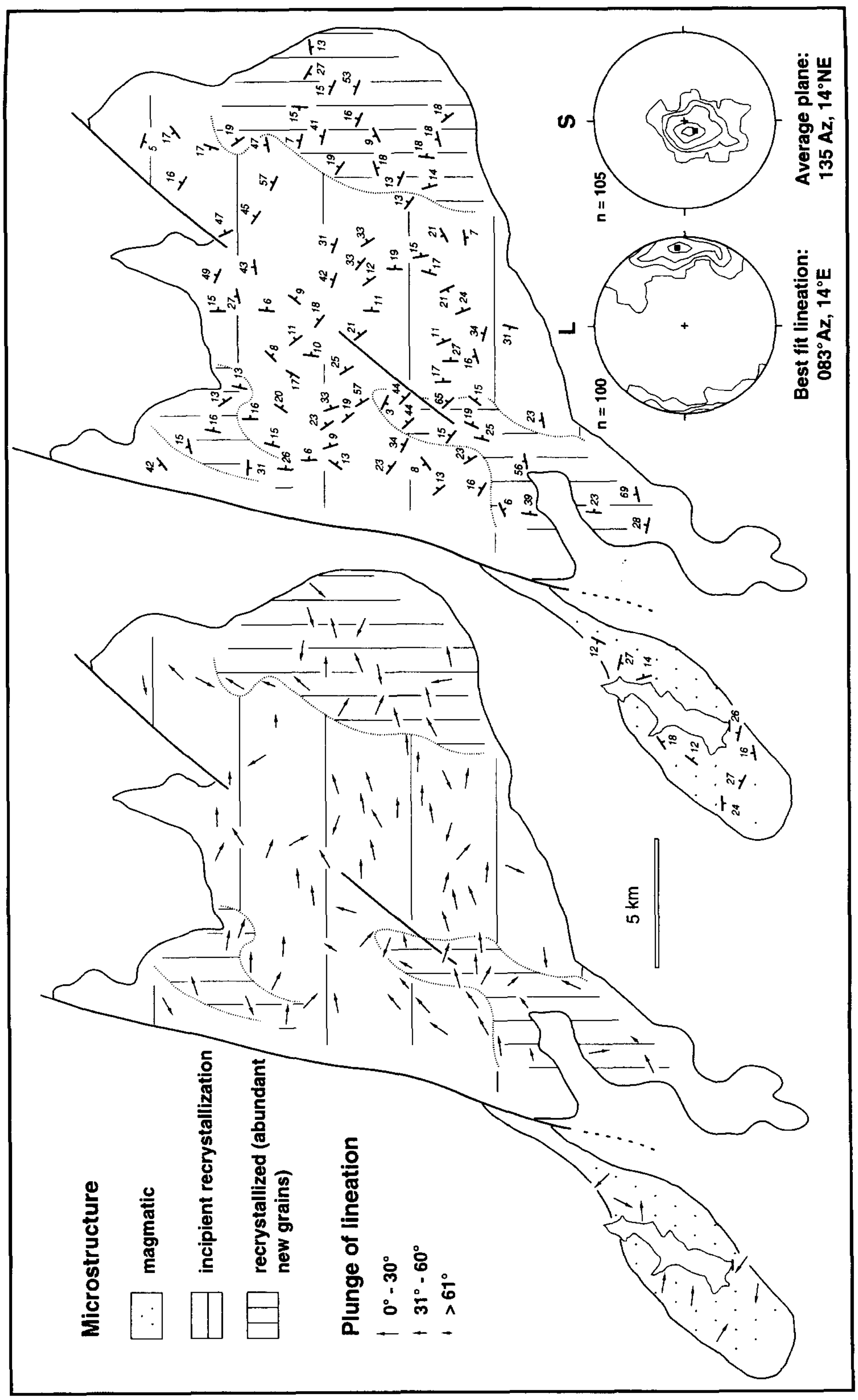

Fig. 8. Magnetic structural maps (*L*, lineation; *S*, foliation) of the Triunfo pluton. Orientation diagrams (equal-area, lower-hemisphere); *n* = number of measurements; contours: 2, 4, 6, 8 and 10% per 1% area.

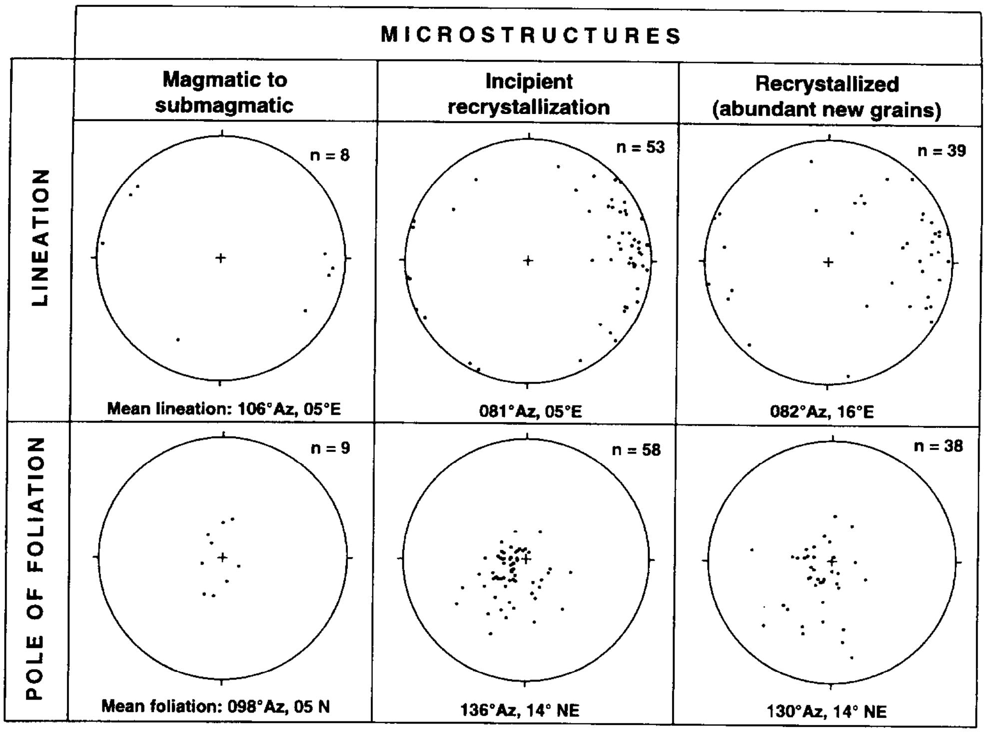

Fig. 9. Magnetic lineation and foliation patterns as a function of the microstructural type. Equal-area, lower-hemisphere diagrams; n = number of measurements.

magnetite grains (Borradaile, 1988; Rochette *et al.*, 1992). In the range of $0.5 < K$ (10^{-3} SI) < 1 (stations 14, 31 and 36), susceptibility magnitudes and anisotropies depend on the contributions of both pyroxene and magnetite.

At stations 14, 31, 32, 35, 36 and 38, the magnetic lineations point to the ENE or to the ESE, and the foliations dip gently eastward. At stations 33 and 34, the lineation trends NW–SE and the foliation dips gently, respectively, to the northeast and southwest. At station 15, the lineation plunge and foliation dip are steeper but do not significantly differ from the magnetic fabric of the other stations. These data indicate that whatever mineralogy controls the magnetic susceptibility, the orientation of principal directions of the AMS remain practically stable from one station to the next.

Since the anisotropy directions do not change along the traverse, this strongly suggests that the silicate fabric of the pluton controls the AMS. In the presence of magnetite, the magnitude of susceptibility and the anisotropy degree values increase with, respectively, the volume percentage of ferrimagnetic grains in the syenite and their shape-preferred orientation. At stations where susceptibility is dominated by magnetite, i.e. those with $K > 10^{-3}$ SI, the fabric of magnetite grains probably mimics the fabric of silicates (Hrouda and Lanza, 1989; Archanjo *et al.*, 1995). At two stations (36 and 38) we have measured the magmatic fabric directly using a compass. At these stations the foliation is marked by layers enriched in green pyroxenes and layers enriched in K-feldspars, and the lineation is marked by the alignment of the pyroxenes. At both stations the gentle eastward dip of the foliation and the plunge of lineation favourably compare with the magnetic fabric measurement, indicating that the magnetic and magmatic fabrics are coaxial.

Grains of magnetite were observed optically only in the recrystallized microstructure. They are small (<0.15 mm), xenomorphic and mostly surround the pyroxene crystals with apparently no shape-preferred orientation. These textures suggest that magnetite results from secondary, late-stage, magmatic crystallization of magnetite along faces of the pyroxene crystals. Since long faces are likely to contain more magnetite grains than the short faces, another factor of magnetic anisotropy, namely distribution anisotropy related to magnetic interactions between the grains of magnetite, is likely to play an additional role (Hargraves *et al.*, 1991; Stephenson, 1993; Grégoire *et al.*, 1995).

AMS of minerals belonging to the pyroxene group is not very well constrained. Augite exhibits anisotropies between $P = 1.2$ and $P = 1.4$, with the axes of maximum and minimum susceptibilities parallel to the long and short crystallographic axes of the crystal, respectively (Hrouda, 1982). In riebeckite, a Fe–Na pyroxene, the magnitude of P seems to be lower than in augite, and the crystal displays a uniaxial oblate symmetry ($k_1 = k_2 > k_3$), with k_3 parallel to the short axis of the crystal (Rochette *et al.*, 1992). Assuming similar low-field AMS properties for the other Fe–Na pyroxenes, the foliation in rocks containing aegirine–augite would be defined by the plane normal to the concentration of k_3 axes, while the

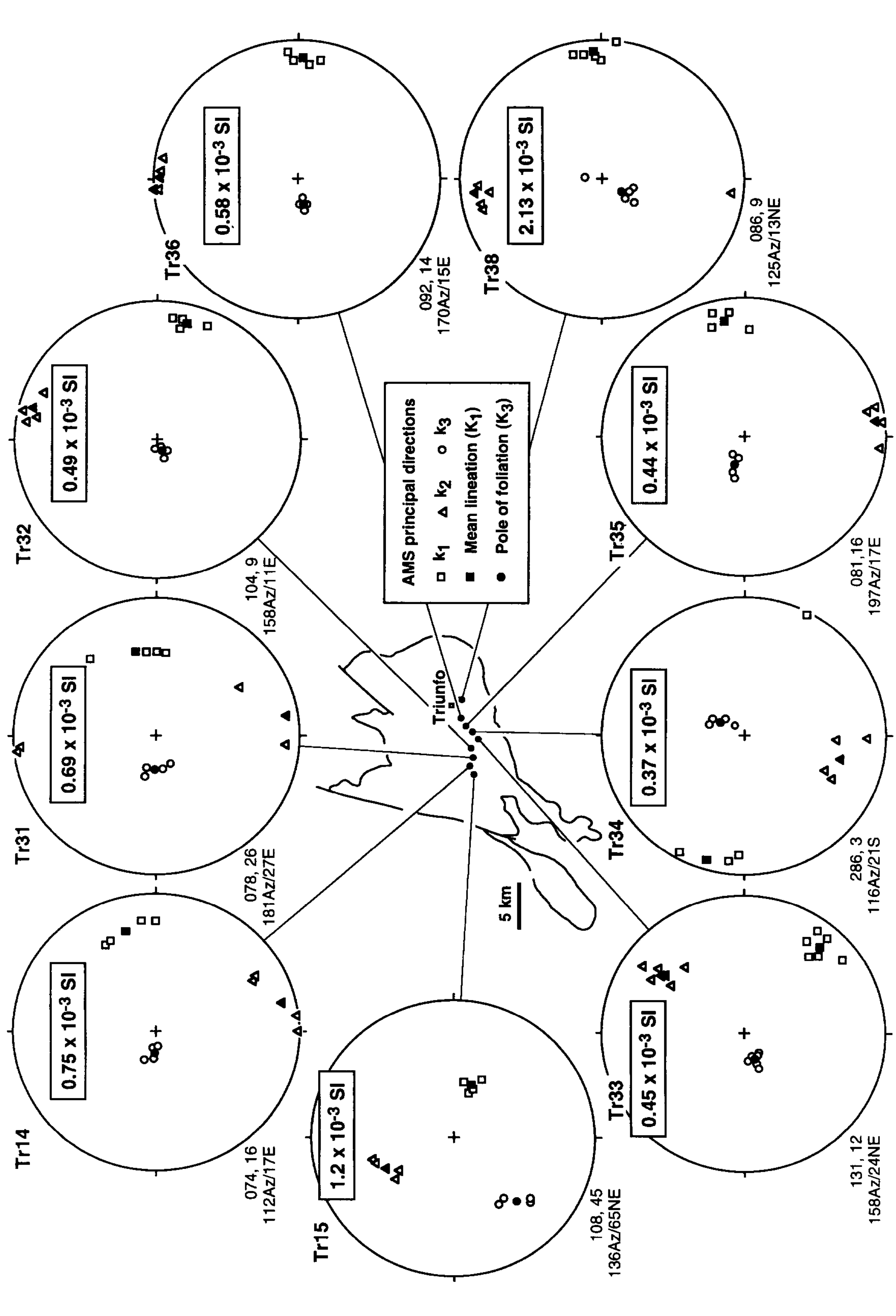

Fig. 10. AMS principal directions for nine stations situated along a 10 km-long traverse trending E–W. In each orientation diagram (equal-area, lower-hemisphere), the mean magnetic susceptibility magnitude is boxed. The attitude of k_1 and k_3 is shown in each diagram (lower left).

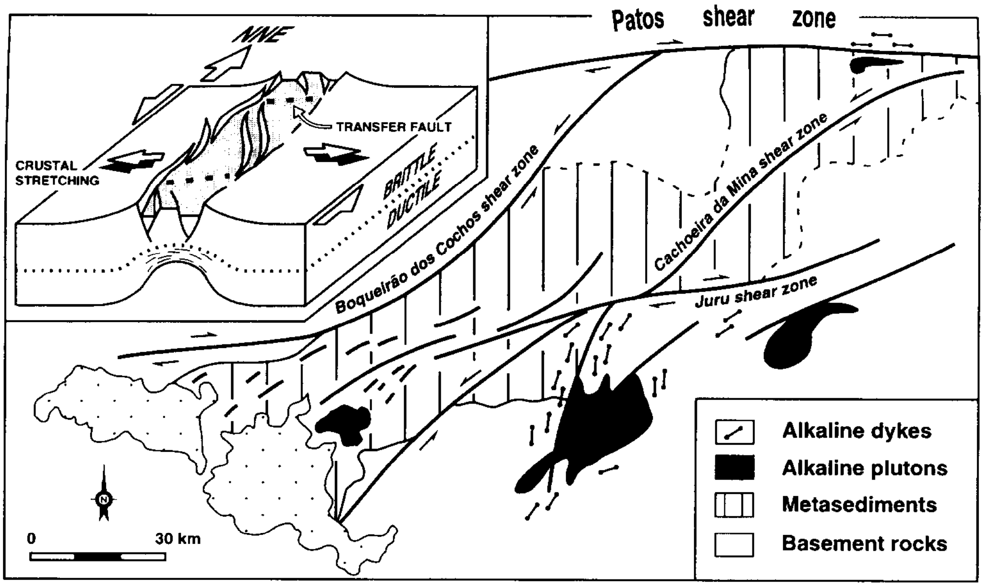

Fig. 11. Alkaline plutons, dykes and shear-zone patterns in the northern domain of the Cachoeirinha–Salgueiro belt. Inset: model of rifting in a low-spreading ridge inspired from Dauteuil and Brun (1993). Note the flat-lying planar structure near the brittle–ductile transition which accommodates a laccolith-like magmatic intrusion formed by lateral migration of the magma after upward propagation from a mantle–lower crust source. In this model, the Juru shear zone could have acted as the oblique transfer fault, the whole system being bounded to the north and to the south, respectively, by the Patos and Pernambuco transcurrent shear zones. In this model the emplacement of Triunfo is coeval with regional-scale shearing, and the magmatic lineation roughly parallels the regional stretching direction.

lineation would be defined, as in sheet silicates, by the zone axis of k_1k_2 planes. In others words, in rocks containing dominant pyroxenes with an uniaxial oblate AMS ellipsoid, a planar magnetic fabric will be developed more easily than a linear fabric.

Pluton emplacement and tectonics

The magnetic fabric suggests that the pluton has a tabular shape as the foliations everywhere are gently dipping. As lineations essentially track the flow direction of the magma during its emplacement, their regular plunge to east at the present level of erosion suggests that magma came from the east. However, no root zone, marked by steep lineations, is found in the pluton. The occurrence of markedly more planar than linear magnetic fabric is consistent with the particularly well-defined foliations. As seen above, the shape of the low-field AMS ellipsoid of the Na–Fe pyroxene may be invoked (Rochette *et al.*, 1992), but this may be insufficient to explain the overall strongly planar magnetic fabric. Pyroxene crystals with intrinsic oblate magnetic anisotropies would not explain alone the oblateness of the fabric, as suggested by well-known magnetic fabrics of granites which are dominated by biotite (an oblate mineral), which are far from being systematically planar (see for example Olivier and Archanjo, 1994). Among the mechanisms that may be invoked to explain the oblateness of the fabric and horizontality of foliation is to consider that the present section of the pluton represents the top part of a magma chamber. However, the regularly directed pattern of the magnetic lineations is not likely to be found on top of a pluton where radial patterns would be expected. Instead, a tabular, laccolith-like body is preferred as a model for intrusion, and the oblate fabric and flat foliations are tentatively accounted for by a pure shear event due to vertical compaction of the magma chamber during the latest stages of emplacement. This late compaction could be coeval with the partial recrystallization of the primary texture during which the magnetite was exsolved from the pyroxene. The coeval expulsion of interstitial melt from the partially crystallized magma is supposed to have contributed to the formation of late-stage aegirine–augite-bearing pegmatites and syenite dykes.

The alignment of peralkaline plutons in the same direction as the strike-slip shear zones suggests that the ascent and emplacement of magma is controlled by deep-seated fractures (Figs 1 & 11). The Triunfo pluton and its associated fine-grained syenitic dykes are bounded by the regional-scale NE-trending sinistral Cachoeira da Mina shear zone (CMSZ) and the ENE-trending dextral Juru shear zone (JSZ) (Fig. 11). The JSZ is not continuous westward; rather it exhibits a NE–SW-trending horse-tail termination toward the Boqueirão dos Cochos shear zone (BCSZ) (Sato, 1987). A tentative tectonic model, which associates peralkaline magmatism and strike-slip faulting, is presented in the inset of Fig. 11. It is inspired by the experiment of Dauteuil and Brun (1993) designed to model an oblique rifting at low spreading rate. Alkaline melts would have migrated upwards by fractures (Clemens and Mawer, 1992) and spread laterally along a major subhorizontal crustal discontinuity, possibly along the brittle–ductile transition, and formed a tabular, laccolith-like, intrusion. In this model, the JSZ would have behaved like a transfer-fault approximately parallel to the stretching direction. In its site of emplacement the magma flow was controlled by the regional stretching direction, i.e. roughly E–W. The proposed model explains several tectono-magmatic features observed in-between the Patos and Pernambuco lineaments such as the alignment of plutons and the transcurrent shear zone system. However, some features predicted in the model have not been observed in the CSB, for example the dip-slip component of movement along the fault planes. Moreover, the relative chronology of the intrusion of alkaline magmas and the onset of strike-slip faulting has not yet been established.

CONCLUSIONS

A laccolithic emplacement for the Triunfo pluton is suggested by its frozen-in pattern of magnetic/magmatic fabric. The overall oblateness of the magnetic fabric may be attributed to the uniaxial oblate low-field AMS ellipsoid of the aegirine–augite crystals and/or to pure shear associated with the vertical compaction of the magma by the end of its emplacement. This hypothetical compaction of the syenitic magma may be related to the conspicuous late recrystallization of small grains of albitic feldspar, epidote and magnetite around large primary grains of K-feldspar and pyroxene. The observed late recrystallization of magnetite is responsible for a net increase in the bulk susceptibility, along with a higher magnetic anisotropy magnitude. However, whatever the mineralogy controlling the AMS, the maximum and minimum principal directions of magnetic susceptibility can be equated with the magmatic lineation and the pole of the magmatic foliation, respectively.

The emplacement of the Triunfo syenite is inferred to have occurred by migration of the magma along deep fractures, followed by it becoming trapped in a subhorizontal crustal structure that finally ended as a sill-like body. The proposed magma migration along vertical fractures is supported by the presence of late, fine-grained, syenitic dykes surrounding the Triunfo pluton and containing aegirine–augite microphenocrysts. The N–S- to NE–SW-trending dykes intruded into isotropic porphyritic granites suggest an overall E–W regional extension which, in conjunction with strike-slip shear zones, controls the emplacement of alkaline magmas of the Cachoeirinha–Salgueiro belt. The very consistent E–W-trending magnetic lineations suggest that the magma flow, in its site of emplacement, was parallel to the regional stretching direction. A strike-slip shear regime, closely associated with crustal extension, may therefore account for the emplacement of post-collisional alkaline plutons of the Brasiliano–Pan-African orogeny of northeast Brazil.

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