MAGNETIC STUDIES ON MESOZOIC DIKE SWARMS FROM SÃO SEBASTIÃO REGION, NE SÃO PAULO STATE, BRAZIL

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ABSTRACT

A total of 85 dikes (diabase and lamprophyres) were studied cropping out along the beaches of São Sebastião (NE of São Paulo). Dikes intrude metamorphic rocks; have thicknesses ranging from a few centimeters up to 2 m for lamprophyres and up to > 10 m to the diabase. They trend predominant N40°-50°E with vertical dip. The magnetic fabrics were determined through both anisotropy of magnetic susceptibility (AMS) and anisotropy of magnetization anhysteretic (AARM). The magnetic properties obtained from various experiments indicate that the magnetic mineral responsible for anisotropy and remanence is magnetite with pseudo-single domain grains. The dominant magnetic fabric for the two swarms is the one expected for dikes and corresponds to magmatic flow. The analysis of K_{max} inclination allowed to infer that the dikes were fed by horizontal (K_{max} <30°) and inclined (K_{max} > 30°) up to vertical flows. Paleomagnetic data indicate two events for diabases and lamprophyres as evidenced by the normal and reverse polarity of the geomagnetic field. These data also indicate that geochemically different sources were simultaneously active.

Keywords: AMS, AARM, Magnetic fabric, Dike swarms, São Sebastião

Introduction

The Mesozoic magmatism in Southern Brazil is represented mainly by the basaltic flows of the Serra Geral Formation, the tholeiitic dikes swarms from the Ponta Grossa Arch, Florianópolis, and along the coast between São Paulo and Rio de Janeiro, as well as several alkaline complexes that lie along tectonic features associated to the evolution of the Paraná Basin. The emplacement of the dike swarms and the alkaline complexes is related to the opening of the Atlantic Ocean.

We are performing an intensive magnetic study (magnetic fabrics, paleomagnetism and rock-magnetism) in all dike swarms from the coastline of São Paulo state, in which the dikes with different chemical composition (tholeiitic, lamprophyre and alkaline) are widespread along the Serra do Mar between São Paulo and Rio de Janeiro. The principal purpose of this study is to apply both AMS and AMR techniques to investigate the magma flow, to provide information on its mode of emplacement, and to investigate the relative position of magma sources and fractures. In addition, we want to determine the paleomagnetic pole(s) of the dike swarms to compare it with available poles from Ponta Grossa (Raposo and Ernesto, 1995a, b) and Florianópolis (Raposo *et al*., 1998) in order to confirm whether they can be of the same age. This is because it is believed that the tholeiitic activity occurred during the Early Cretaceous, and it was then partly coeval with Ponta Grossa and Florianópolis dikes (*e.g.* Almeida, 1986); the other dikes are, however, younger than the diabases (Almeida, 1986). In order to have a good control of the magnetic carriers, we also performed an extensive rock magnetism study. In this paper we show results from the São Sebastião dikes.

The studied swarms crosscut Archean and Proterozoic polymetamorphosed rocks of the Costeiro Complex. The dikes are diabases and lamprophyres, and they crop out side by side in the beaches. They range from a few centimeters up to 2 m wide for the lamprophyres, and up to > 10 m for the diabase. Their trend is predominately N40°-50°E with vertical dips.

Magnetic Measurements

Magnetic studies were performed on oriented samples collected symmetrically (whenever possible) from both margins of the dikes together with the center. At least 15 and up to 20 cores, using a gasoline-powered rock drill, were collected from each dike for which the strike and thickness could be determined. A total of 85 dikes were studied in this paper. Magnetic fabrics were determined by applying both anisotropy of low-field magnetic susceptibility (AMS) and anisotropy of anhysteretic remanent magnetization (AARM). Rock-magnetism was obtained from several diagnostic experiments including field dependency of susceptibility. Paleomagnetism was determined by both thermal and AF demagnetizations.

AMS Fabric

The dominant AMS fabric in the swarms is that expected for dikes, and is called a normal fabric (Rochette et al., 1992). It is characterized by having the AMS foliation (K_{max}-K_{int} plane) nearly parallel to the dike plane whereas the AMS foliation pole (K_{min}) is nearly perpendicular to it (Fig. 1). Anomalous AMS fabrics known as inverse and intermediate were also found (Fig. 1). The inverse fabric is defined by K_{int} and K_{min} axes clustering close to dike plane and K_{max} axes nearly perpendicular to this plane, whereas the intermediate fabric is defined by K_{max} and K_{min} axes clustering close to dike plane and K_{int} axes nearly perpendicular to this plane. The AARM fabric is either coaxial or better defined than AMS fabric. The AARM fabric is coaxial for the majority of dikes including those with Inverse and Intermediate AMS fabrics.

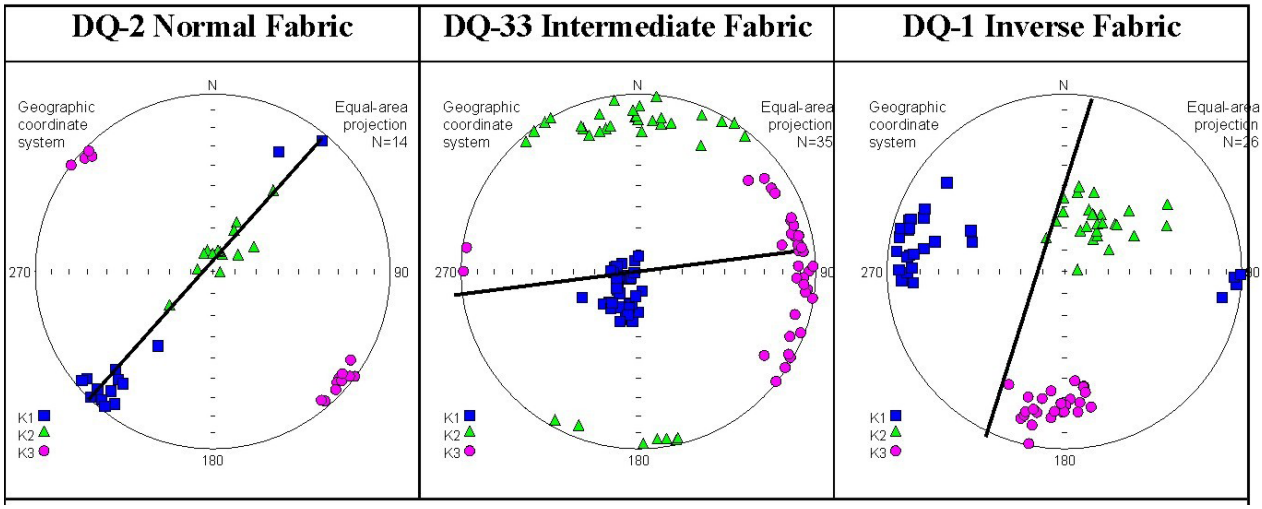

Figure 1. Examples of magnetic fabrics for the studied swarms

Rock Magnetism Properties.

Rock magnetism properties indicate that pseudo-single-domain grains of almost pure magnetite carry the magnetic fabrics. For some dikes, magnetic susceptibility is dependent on field intensity whereas in the rest, K is field-independent. The K variation with field intensity suggests that titanomagnetite (Hrouda, 2009) could be present in the dikes, which is corroborated with high KxT curves.

Discussion

Normal AMS fabric is interpreted as the result of magma flow in both swarms. The analysis of the K_{max} inclination allowed to infer that the dikes from both swarms were fed by horizontal flow ($K_{max} < 30°$), suggesting that they were far away from the magma source. On the other hand, other dikes were fed by inclined ($K_{max}>30°$) up to vertical flows suggesting that they were close to the magma source. Horizontal and inclined flows in dikes in both swarms can indicate either some movement of South American plate or

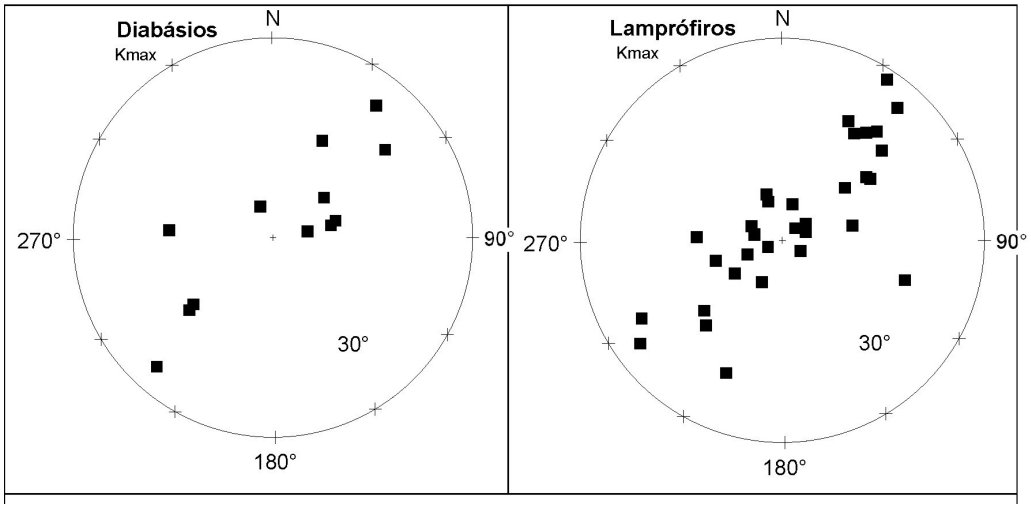

Figure.2. *Kmax* inclination for diabase and lamprophyric dikes with magma flow fabric.

more than one magma source for diabases and lamprophyres (Fig. 2).

Paleomagnetic studies show that the swarms register normal and reverse polarity (Fig. 3). The mean remanent magnetization direction from swarms suggests two intrusion events for both swarms and that the

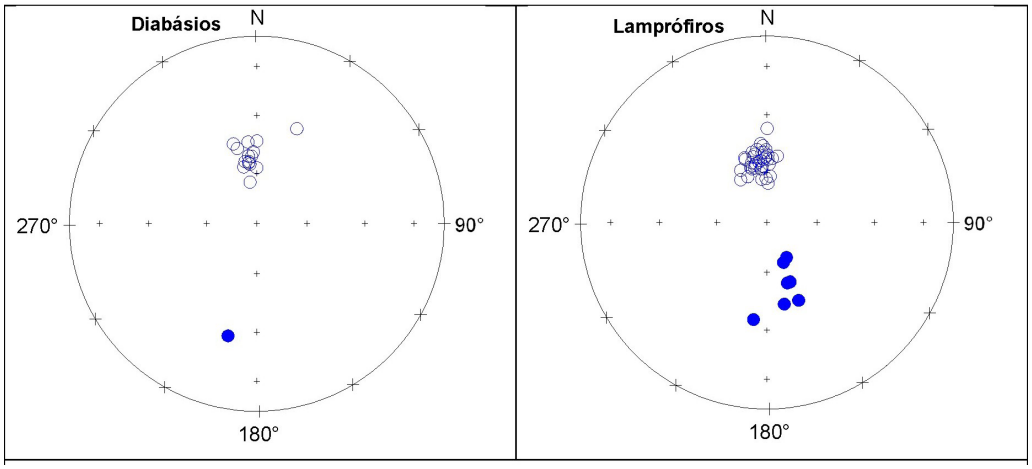

Figure 3. Paleomagnetic data for the studied dikes.

sources that gave rise to lamprophyre and diabase dikes were active at the same time.

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