

## Magnetic studies on mesozoic dike swarms from the coastline of São Paulo state (SE Brazil).

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**Abstract:** 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, and several alkaline complexes that lie along tectonic features associated with the evolution of the Paraná Basin. This magmatism is called as Paraná-Etendeka Magmatic Province. The emplacement of the dike swarms and the alkaline complexes is related to the processes of separation between South America and Africa, and with the opening of 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 and beaches between São Paulo and Rio de Janeiro. The principal purpose of this study is to apply both AMS and AARM 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, and 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) to verify whether they can be the same age since it is believed that the tholeiitic activity occurred during the Early Cretaceous and 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). To have a good control of the magnetic carriers we also are performing an extensive rock magnetism study.

The studied swarms occur along the coast NE of São Paulo State, and crosscut Archean and Proterozoic polymetamorphosed rocks of the Costeiro Complex. The dikes are diabases, alkaline 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 alkaline, and up to > 10 m for the diabase. Their trend is predominately N40°-50°E with vertical dips.

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 247 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). Paleomagnetism was determined by both thermal and AF demagnetizations.

Rock magnetism properties indicate that pseudo-single-domain grains of almost pure magnetite carry the magnetic fabrics and the remanence. However, all lamprophyre dikes from Ubatuba region show an unusual magnetic behavior mainly for low  $KxT$  curves. The magnetic susceptibility of these dikes is dependent of field intensity while in the basic and alkaline dikes  $K$  is field-independent. The  $K$  variation with field intensity suggests that titanomagnetite (Hrouda, 2009) could be present in the lamprophyre dikes, which is corroborated with high  $KxT$  curves. Low temperature magnetic measurements down to 10 K for these dikes suggest the presence of the iron carbonate siderite (Raposo and Berquó, 2011). Maybe this mineral could explain the anomalous behavior for low  $KxT$  curves (?)

The dominant AMS fabric in all swarms is related to magma flow in which the AMS foliation ( $K_{\max}$ - $K_{\text{int}}$  plane) is nearly parallel to the dike plane whereas the AMS foliation pole ( $K_{\min}$ ) is nearly perpendicular to it. The analysis of the  $K_{\max}$  inclination permitted to infer that the dikes from the swarms were fed by horizontal ( $K_{\max} < 30^\circ$ ), inclined ( $30^\circ < K_{\max} < 60^\circ$ ) and vertical ( $K_{\max} > 60^\circ$ ) flows. Horizontal up to vertical flows in the dikes swarms can indicate either some movement of South American plate or more than one magma source for diabases, lamprophyres and alkaline as well. The anomalous AMS fabric *Inverse and intermediate* fabrics were also found. The AARM fabric is either coaxial, non-coaxial or better defined than AMS fabric

Paleomagnetic studies show that the swarms register normal and reverse polarity. The mean remanent magnetization direction from the swarms suggests that the sources which give rise lamprophyre, diabase and alkaline dikes were active at the same time when the geomagnetic field was normal and reverse polarity.

**Keywords:** AMS, Paleomagnetism, dike swarm, Paraná-Etendeka Magmatic Province.

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