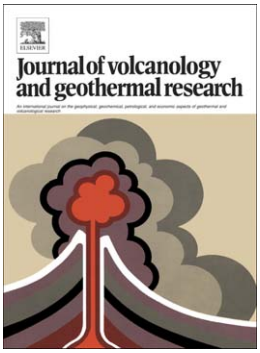

A revised chemo- chrono-stratigraphic 4-D model for the extrusive rocks of the Paraná Igneous Province

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1. INTRODUCTION

A new chemical-based proposal to divide the volcanic rocks that comprise the Paraná Igneous Province (PIP) may seem outdated, misplaced and inappropriate. It could be argued that there is just another set of criteria and new names that would only confuse a widely accepted framework established by Mantovani *et al.* (1988), Peate (1989), Peate *et al*. (1990, 1992) and Peate (1997). However, a new geochemical typology is reasonable given the huge volume of geochemical data produced to date, the new techniques for data treatment and the criteria used to delimit different types. Therefore, a proposal of a four dimensional (space and time) regional chemo- and chrono-stratigraphic model, based on these concerns, is well grounded.

The geochemical database used in this article is an extended version of that previously presented by Licht & Arioli (2012a) with 4,257 samples. It includes new data produced during the geological mapping of the central Paraná Igneous Province, in the Brazilian State of Paraná (Arioli & Licht 2014), reaching 5,974 surface and sub-surface samples, which comprise several rock types from the whole province.

A trial to classify samples from this database in six *basalt* (*sensu latu*) '*magma-types'* using the *'step-by-step'* procedure presented by Peate (1989) reached a success rate of 53%, i.e., only 2,609 samples were classified from a total of 4,895 intrusive and extrusive rocks. This failure may be explained by the following reasons: (1) the criteria defined by Peate (1989) were obtained using a restricted database; (2) consequently, these criteria are too complex to be applied to such an enormous database; (3) the '*step-by-step*' application contains ambiguous and overlapping limits; (4) the criteria that were established by Peate (1989) and also reviewed by Peate *et al.* (1992) consider all samples contained in the database, i.e., not discarding those >2% LOI (Loss On Ignition). These caveats were considered as sufficient justifications for deepening the research, in order to establish a classification system based on well-defined and clear limiting numerical criteria, which displays no overlaps between categories and a consistent geographical distribution of the samples collected in outcrops and boreholes.

As adopted by many previous authors (e.g., Rüegg 1969, 1970, 1975, 1976; Rüegg & Amaral 1976; Bellieni *et al.* 1983, 1984a, 1984b; Atalla *et al.* 1982; Sousa 1983; Marques 1983; Mantovani *et al.*1985, 1988; Bellieni *et al.* 1986; Fodor 1987; Petrini *et al.* 1987), SiO_2, Zr, TiO_2 and P_2O_5 have also been chosen as geochemical vectors to discriminate the Paraná Igneous Province volcanic rocks in the present study.

The main objectives of this article are: (1) to present simple, clear and objective criteria for the separation of extrusive rocks of the province; (2) to characterize lavas geochemically from the LSi and HSi types; (3) to present a bi-dimensional distribution of LSi and HSi volcanic rocks of