Statistical techniques applied to large geochemical databases: A case study on the Paraná Igneous Province, Southern Brazil

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Statistical analysis (frequency tables, histograms and probability plots) of a lithogeochemical database containing 5,974 outcrop and borehole samples covering the whole Paraná Igneous Province (PIP) revealed that natural gaps separate populations of SiO_2 (62.02%), Zr (522.15 µg/g), TiO_2 (2.85%) and P_2O_5 (0.413%) into subpopulations of low and high values. A system based on the 16 combinations formed by these subpopulations was used to classify the 3,296 samples of extrusive rocks with LOI <2%. Thus, three main geochemical types could be recognized: (1) Southern Type 1 (LSi-LZr-LTi-LP) rocks, with relatively high SiO_2, Al_2O_3, Na_2O, Rb, Cs, Th, and U contents; (2) Type 4 (LSi-LZr-HTi-HP) rocks, enriched in K_2O, Ba, F, Nb, Sr, Ta, Y, Zr and REE; (3) Central-Northern Type 1 (LSi-LZr-LTi-LP) rocks, enriched in MgO, CaO, Cr, Cu, Ni, Pd and Pt. The same statistical approaches previously used were then applied again to a specific group of 876 chip samples obtained during the drilling of seven deep boreholes in the central area of the PIP (State of Paraná) in order to detail chemical variations of incompatible (K_2O, F, Nb and La) and compatible elements (Cr, Ni, Cu and Pd) in Type 4 and Central-Northern Type 1 rocks, respectively. This revealed the existence of statistical gaps of K_2O (1.81%), F (663 µg/g), Nb (27.105 µg/g) and La (40.19 µg/g) for the Type 4 samples and of Cr (95 µg/g), Ni (60.88 µg/g), Cu (288.83 µg/g) and Pd (18.945 ng/g) for the Central-Northern Type 1 samples. Hence, these two types could be divided into several subtypes. The Type 4 rocks in the base of the volcanic pile mainly comprises layers of LK-LF-LNb-LLa volcanics interbedded with LK-HF-LNb-LLa, LK-LF-HNb-LLa, LK-HF-HNb-LLa and HK-HF-HNb-HLa rocks, which may represent batches of more evolved melts. On the other hand, the Central-Northern Type 1 rocks in the upper part of the sequence consist of layers of HCr-HNi-LCu-LPd, LCr-LNi-HCu-LPd, LCr-LNi-LCu-HPd and LCr-LNi-HCu-HPd volcanics, which may represent batches of more primitive melts. This high-resolution model for the chemostratigraphy of the PIP is expected to contribute to new insights on its origin and evolution.