Statistically Correct Methodology for Compositional Data in New Discriminant Function Tectonomagmatic Diagrams and Application to Ophiolite Origin

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In this lead presentation, we draw the attention of all geoscientists around the world to the urgent need of correct statistical treatment of geochemical data. Independently of the data quality, the compositional data represent statistical samples drawn from populations of "closed" space limited to 0-1 or 0-100%. Most diagrams used in geochemical work for interpreting compositional data violate the basic statistical assumptions of open space for all variables. Appropriate procedures for theoretically opening up the space to infinite values and thus correctly handling statistical samples drawn from such closed space populations have been available for the past 25 years. Discrimination diagrams to decipher tectonic settings have been in use for nearly 40 years. They seem to constitute one of the most frequently used tools, if not the only one, to infer tectonic setting of older (Pre-Tertiary) rocks like in India and of complex areas with multiple tectonic settings such as in Mexico and Turkey. Recently (during 2004-2010) researchers from India and Mexico have proposed new tectonomagmatic discrimination diagrams based on natural logarithm-transformation of appropriate element ratio variables and linear discriminant analysis (LDA). Specifically, one set of diagrams proposed in 2004 is based on LDA of ratio variables of major-elements in basic and ultrabasic magmas, without log-transformation. The diagrams published in 2006 based on major-elements and those made available in 2008 and 2010 based on immobile elements fully comply with the above requirement of open space. These diagrams fulfil all other statistical requirements, besides correctly handling compositional data, such as multivariate nature of compositional variables, representative sampling, and probability-based tectonic field boundaries. In the most recent proposal of 2010, statistical samples of the normally distributed, discordant-outlier free, log-ratio variables were also achieved prior to LDA. In these four sets of five diagrams for each set, the tectonomagmatic discrimination was successfully documented for four tectonic settings (island arc, continental rift, ocean-island, and mid-ocean ridge). The diagrams have been extensively evaluated for their performance in several studies by different workers. In this work, we apply these new diagrams to infer tectonic setting of several ophiolites around the world, and point out the success as well as limitations of this application. This is being done because ophiolites are known to host important mineral deposits, including platinum-group elements (PGE).