Compositional data analysis on the the stream sediment geochemical data at the Duolong mineral district, Tibet, China

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Abstract

The Duolong mineral district is a newly discovered area with porphyry and epithermal Cu-Au ore deposits in the north Tibet, China (Li and others, 2007). Formation of these deposits is genetically related to the porphyritic granitoids emplaced below these deposits at an isochron age of 121~126 Ma (Song and others, 2014). Our aim is to analyze the stream sediment geochemical data and aid in mineral exploration in this area.

Currently used dataset are geological data and the stream sediment geochemical data. The geological data include the location of 10 porphyry Cu-Au deposits, fault traces, lithological units, and outcrops of magmatic rocks. The geochemical data at 1:50,000 scale with 0.5 km spatial resolution are composed of 3,217 samples and each sample records concentration values of 15 trace elements (Cu, Au, Pb, Zn, Cr, Ni, Mn, Ag, Sn, W, Mo, As, Sb, Bi, and Hg).

Principle component analysis (PCA) was employed with the log-transformed geochemical data and the data after isometric log-ratio (ILR) transformation (Egozcue and others, 2003). Rays of log-based PCA shows that all the elements except Cr are positive in the first component (Fig. 2), which is geochemically puzzling and reflects the closure effect. In contrast, the closure effect is opened in the biplot of ILR-based PCA (Filzmoser and others, 2010). For the ILR-based PCA, most elements (Cu, Pb, Zn, Ag, Mo, As, Sb, and Bi) positive in the first component are the chalcophile elements that readily form sulfides (White, 2013, p.261). Sulfides are the main ore minerals at the porphyry Cu-Au deposits in this area (Li and others, 2007). Therefore, high values of these elements indicate a large probability of ore formation. The elements negative in the first component (Cr, Ni, Mn, W, Sn, and Hg) are lithophile or siderophile elements in the Goldschmidt's Classification (White, 2013, p.261). Cr and Ni may reflect the influences of mafic and ultramafic rocks. W, Sn, and Mn are the lithophile elements that have an affinity for oxygen (White, 2013, p.261). Hg is a chalcophile element but often present in the distal parts of the primary halo of magmatic-hydrothermal deposits (Pirajno, 2009, p.363). Therefore, high values of these elements mean a low probability of ore formation. Thus, the scores of the first component can be used to predict the mineral potential in this area. Fig. 3 shows that eight ore deposits are discovered in three zones (zone1, zone2, and zone3) with high scores. Zone4 has two ore deposits but its scores are lower than previous three zones. High scores locate in Zone5 but no ore deposits have been discovered yet. We suggest that further investigation should be conducted to evaluate its potential.

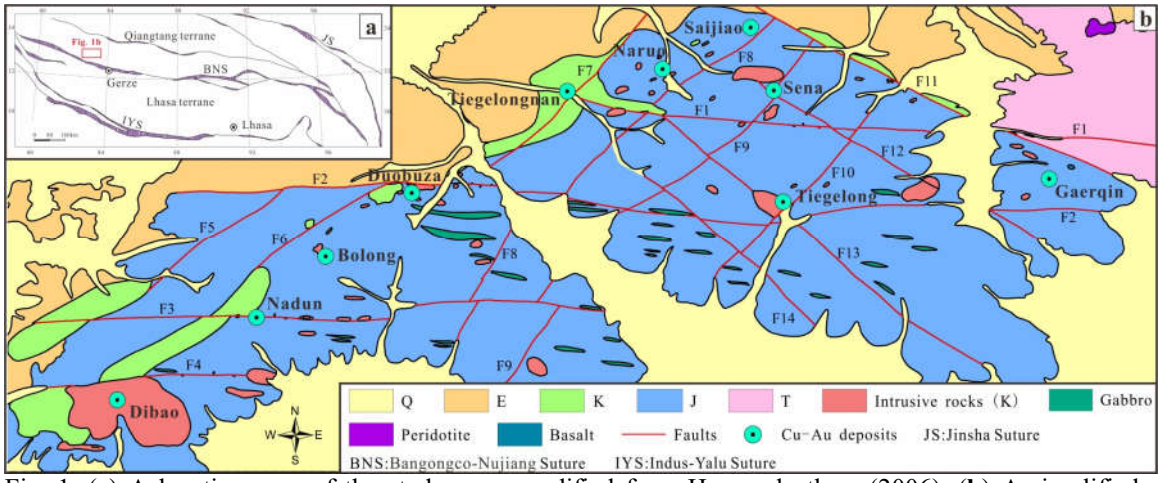

Fig. 1. (a) A location map of the study area, modified from Hou and others (2006). (**b**) A simplified geological map of the Duolong mineral district, Tibet China.

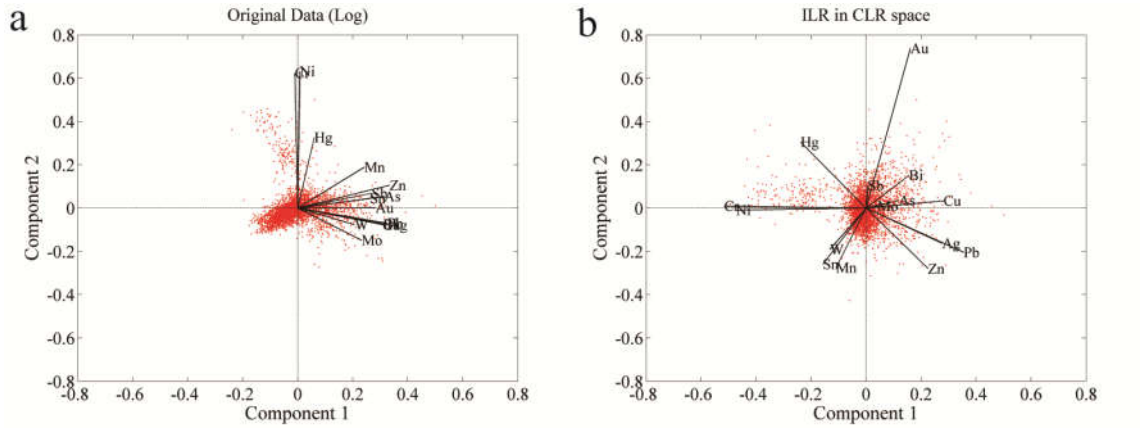

Fig. 2 Biplot of principle component analysis of the original data (a) and ILR transformed data

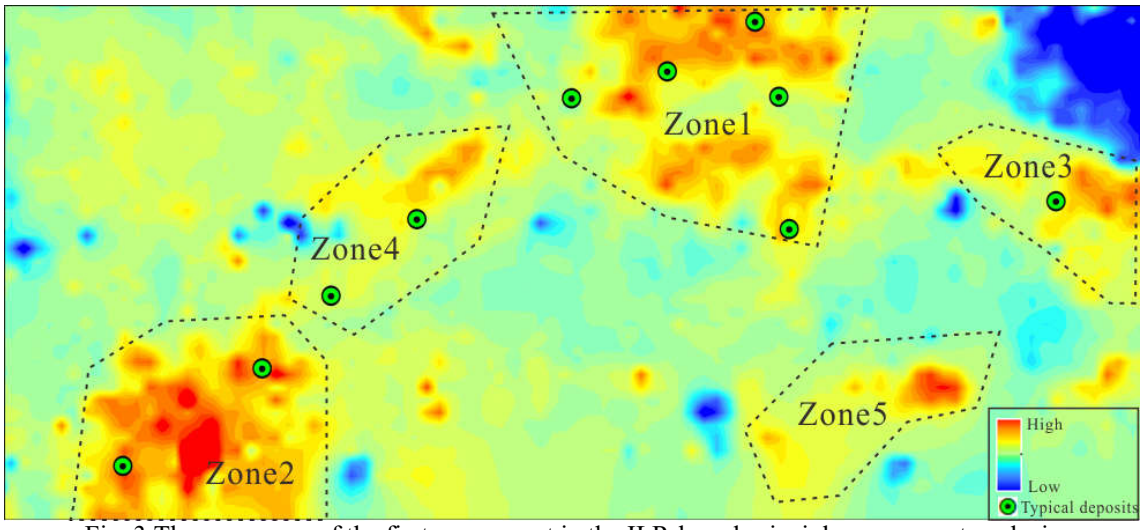

Fig. 3 The score map of the first component in the ILR-based principle component analysis

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