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Anisotropic singularity: a novel way to characterize controlling effects of geological processes

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Singularity theory which can quantitatively characterize geological processes or events accompanied with energy release and material accumulation has been broadly discussed in the past decade. Generally using a window-based method, singularity index indicative to variations of physical-chemical signatures are efficient to investigate their causative geological processes or events in a spatial scenario. Among previous case studies, singularity index was estimated by the vicinity of each location that is isotropic. Although it is efficient to delineate spaces with material (e.g., ore element, energy, rainfall) accumulations, geochemical and/or geophysical distributions are often anisotropic that often happened at the sub-tectonic structures. Therefore, in addition to characterize general spatial variation of geochemical or geophysical distributions, anisotropic singularity is necessary to be implemented to further gain more detailed geo-information descriptive to targets of interest where anisotropy often occur. This study further develops the window-based isotropic singularity index estimation method which using the increasing and decreasing relations between concentrations of a list of square windows (ri×ri) and window size (ri×ri) to indicate material accumulation and depletion. According to the newly constructed algorithm or method the decreasing and increasing relations have been changed to the one between a list of rectangular windows (r×ri) in a certain directions and the changes of window size (ri). Another difference is that the list of windows (r×ri) need to rotate from 0 degree to 360 degree to estimate singularity indices along different directions, and the singularity index descriptive to maximum variation will be chosen. Repeating these two steps across the space, the spatial distribution of the anisotropic singularity indices can be delineated. Using the Malipo mineral district, Southeastern Yunnan, China as an example, the anisotropic singularity is implemented. In comparison with isotropic singularity, newly achieved result is more sensitive to the areas of fault intersections and boundaries of intrusions that improves the interpretation to the causative geological processes or events.