3D geochemical exploration in Luanchuan district, China

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The Luanchuan district in the Henan province of China is known for its large porphyry-skarn type Mo deposits and hydrothermal vein type Pb-Zn-Ag deposits. Jurassic intrusions are associated with Mo-W deposits, whereas the Luanchuan Group is associated with Pb-Zn-Ag deposits. The Pb-Zn-Ag deposits are distributed around the Jurassic porphyry-Mo intrusions and hosted in a metamorphic sedimentary formation consisting of terrigenous clastic rock and carbonatite of either Mesoproterozoic or Neoproterozoic age, which is intruded by Neoproterozoic gabbro and syenite and Jurassic acidic porphyries. The Mo and Pb-Zn-Ag deposits are controlled by Jurassic structural and magmatic activities. Anticline structure is associated with the Mo-W deposits, whereas syncline structure is associated with the Pb-Zn-Ag deposits. However, in fault and fold structrual zones, porphyry intrusions can generate complex and multiple types of mineral deposits. For example, the outcropping Yuku porphyry-type Mo-W deposit led to the discovery at depth of the hydrothermal vein-type Pb-Zn-Ag orebody in the Luanchuan Formation based on borehole data. Thus, analysis and integration of exploration data sets in three-dimension (3D) is desirable

Multiple scales and multiple types of geochemical exploration datasets were used to identify mineral potential targets in 3D. The vertical range of the datasets is less than 2.5 km. District scale (1:50,000) stream sediment multi-element geochemical were analyzed using multifractal modeling, resulting in delineation of Mo-W anomalies zones associated with intrusions and and Pb-Zn-Ag anomalies associated with the Luanchuan Formation, and NW- and NE-trending fault structures. The anomalous zones were further used to identify potential targets by integrating the information with a '2.5D' geological model (e.g., mineralized strata and Jurassic intrusions) based on 1:10,000 scale digital elevation model of the study area. Prospect scale (1:2,000) structural-lithological data and 14-element lithogeochemical data along nine exploration lines (105 km) were analyzed and integrated, resulting in delineation of Mo-W and Pb-Zn-Ag mineralized zones. The lithogeochemical data were analyzed using PCA and multifractal mapping. The delineated mineralized zones were further used in conjunction with a 3D geological model of the study area [1] to identify concealed Mo and Pb-Zn-Ag deposits. Deposit-scale borehole geological and geochemical data were used (a) to delineate probable mineralized zones by multifractal concentration-volume modeling of geochemical data and (b) and to estimate metal resources by fractal modeling based on available orebody thickness and metal grade data. The analyses resulted in identification of eight potential Mo targets and 15 potential Pb–Zn–Ag targets.

[1] Wang et al (2011) *Computers & Geosciences* **37**, 1976-1988.

Types and metallogenic age of molybdenum deposits in Eastern Jilin Province, NE China

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The eastern Jilin Province is an important molybdenum metallogenic centralized region, besides the Daheishan deposit (super large-scale), over ten large or medium-scale molybdenum deposits have been discovered in recent ten years, such as Fuanpu, Jidetun, Dashihe, Liushengdian and Shuangshan molybdenum deposits. The rich molybdenum resources have drawn much attentions. According to the newly research data, molybdenum deposits in this area generally belong to the porphyry type, but the mineralization types can be listed as veinlet-disseminated type and stringer-network vein type.

The Daheishan molybdenum deposit is one of typical veinlet-disseminated porphyry deposits. The molybdenum ore bodies are hosted in a complex massif which is mainly consisted of the granodiorite porphyry and biotite granodiorite, and composed of veinlet-disseminated molybdenites. The zonation of mineralization and wall-rock alteration is obvious. The granodiorite porphyry in the complex massif playing an important role in molybdenum mineralization has a zircon U-Pb age of (170±3) Ma[1], and the Re-Os isochron age of molybdenites is (168±3.2) Ma[2], which suggest that Daheishan molybdenum deposit was formed in early Yanshanian period.

Comparatively, the stringer-network molybdenum mineralization is more common and important than the veinlet-disseminated mineralization in this area. Such newly discovered deposits as Liushengdian, Dashihe and Shuangshan molybdenum deposits belong to this type. The similar characteristics of these deposits are as follows. Firstly, most molybdenum ore bodies are consisted of quartz-molybdenite veins accompanying a spot of single molybdenite veins. Secondly, the wall-rock alteration zonation is ofen weak or even lacking. Thirdly, not all the ore-bearing rock-bodies are metallogenic rock-bodies, for example, the currently discovered ore bodies of Dashihe deposit are all hosted in Neo-proterozoic strata made up of epimetamorphic rocks. The Re-Os weighted mean ages of Liushengdian, Dashihe, and Shuangshan deposits are (169.36±0.97) Ma, (186.7±5) Ma and (173.3±1.1) Ma, indicating that molybdenum mineralization took place in early Yanshanian period.

The molybdenum deposits which occurred in eastern area of Jilin Province are the products of porphyry-fluid metallogenic system and mainly formed in early Yanshanian period (metallogenic ages vary from 190Ma to 165Ma). Metallogenic process was possibly influenced by the subductin of the Pacific plate. There are two mineralization types including veinlet-disseminated type and stringer-network vein type, and most belong to the latter. The stringer-network vein is a significant prospecting indicator in this area.

[1] GE et al. (2007) *Chinese Science Bulletin*. **52**, 2407-2417. [2] WANG et al. (2009) *Rock and Mineral Analysis*. **28**, 269-273.