Application of X-ray fluorescence measurement technology in rapid ore prospecting

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1 Introduction

Many geophysical and geochemical methods could be chosen for prospecting, but it is impossible to use one by one in the practical works. Therefore, the selected method has a significant impact on the efficiency and effectiveness of prospecting. As a radiation sampling method, X-ray fluorescence measurement (XRF) is widely used in environmental pollution survey, archaeology, mineral prospecting and manufacturing industry because it is characterized by fast, low cost and portable (Peinado, et al., 2010; Ardida, et al., 2004; Melquiades, et al., 2011; Morgenstein, et al., 2005). The capacity of extracting anomaly information in suit makes this method developing quickly in mineral prospecting. With the development of X-ray fluorescence measurement technology, various working methods are proposed, such as soil XRF, rock XRF, shallow drill XRF and micro-area XRF. In this research, three methods were used for mineral prospecting in selected area, in order to establish a set of rapid field work method based on X-ray fluorescence measurement to improve exploration efficiency.

2 Geological background

The study area is located 24km to the northeast of the Yining County, Xinjiang Province. This area lies in Tulasu volcanic rift basin that south to the Yili massif and north to the North Tianshan island arc (Wang, 2009). The exposed strata in the study area are subdivided into three major packages: 1) lower Carboniferous Dahalajunshan formation tuffs, andesite; 2) upper Carboniferous Dongtujinhe formation sandstones, biolithite; 3) upper Pliocene Changjihe formation sandstones interbedded with biomicrite. The igneous rock intruded in the north of the area including monzonitic granite, granite porphyry and adamellite. NW-striking structures are well developed in the working area. There are a number of gold deposits have been founded surrounding
the area since 1980, such as Axi, Jingxi and Yiermande (Zhai, et al., 1999, 2009; Zhu, et al., 2010). Together with other polymetallic ore deposits make this area is of great metallogenic potential.

3 X-ray fluorescence measurement technology

3.1 Soil X-ray fluorescence measurement

Soil X-ray fluorescence measurement strictly follow the specification of 1:10000 geochemical survey to gain the element anomaly information. The results show that there are two significantly element anomalies. YC-1 occurs in the contact between andesite of Dahalajunshan formation and sandstones of Dongtujinhe formation. The anomaly area is about 0.009 km². The concentrations of Cu and Zn are up to 100355 ppm, 3479.9 ppm respectively. YC-2 lies in the boundary of Dahalajunshan formation and mostly overlain by Quaternary system. However, YC-2 might be similarly occurs in the contact between andesite and sandstones considering the strike of the strata. The anomaly area is about 0.052 km². The copper and zinc concentration measured by XRF are up to 115694 ppm, 6303 ppm respectively. Both of the two anomalies are distributed along the NW-striking structures.

3.2 Shallow drill X-ray fluorescence measurement

In order to survey the distribution of anomalies under the surface, we combined with portable drilling machine and X-ray fluorescence analysis in the practical work, the maximum drilling depth is up to 23m. Seventeen shallow drills carried out through the mineralized area with the distance of 5 meters. The length of whole shallow drill section is about 65 meters. Cumulative drilling depth is about 55 meters. Then, the collected core analyzed by XRF after geological documentation. In order to ensure the accuracy of the measurement, we measured twice every 30cm. the results suggested that Nos. 5, 6, 17 drills have high copper concentration of 10606 ppm, 682 ppm, 10054 ppm respectively.

3.3 Micro X-ray fluorescence measurement

In the field work, we found many metallic minerals in the altered rocks. However, we could not distinguish these minerals just by visual observation easily and even hard to know their chemical component. Therefore, Micro X-ray fluorescence probe developed by Chengdu University of Technology applied to determine the element content of metallic minerals in altered rocks (Fig.1). Focal spot diameter is 54 um and measuring time is 200 s. The results are shown in Table 1. The chemical components of minerals are mainly copper and zinc. Accompanying the microscopic observation, we could assure the minerals are chalcopyrite and bornite.

Figure 1 Photograph of the micro-XRF spectrometer
Table 1  micro-XRF measuring results of copper minerals

<table>
<thead>
<tr>
<th>Number</th>
<th>Fe</th>
<th>Ni</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20.71</td>
<td>3.07</td>
<td>37.6</td>
<td>5.78</td>
</tr>
<tr>
<td>2</td>
<td>6.76</td>
<td>4.77</td>
<td>89.74</td>
<td>6.41</td>
</tr>
</tbody>
</table>

Note: the unit is cpm.

4 Conclusion

As a non-destructive, in situ, portable, low-cost analysis technology, x-ray fluorescence measurement is widely used in many fields. In the field work, soil, core and minerals were measured by different x-ray fluorescence technology which could be used during the different stages of prospecting to improve the efficiency of prospecting. The set of method achieved good results in mineral resource prospecting in Xinjiang.

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References


