An Application of Cluster Analysis Methods to Mine Water Monitoring Data

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Abstract. An optimized model of multivariate classification for the mine water of Xin Shuguang coal power plant coal mine in the north of China, has been developed. Eight samples were grouped in five distinct classes by cluster techniques (CA). The chemical composition of each sample of water is plotted on the piper's three-line and pie chart. The Hierarchical Cluster analysis method was used to analyze the water source at the coal outlet point. These jobs will help the coal mine to better control groundwater damage.

1. Introduction
In the process of coal mining, groundwater often becomes a geological disaster. Hydrogeologists can help hydrogeologists by studying the water chemistry of aquifers in coal mines. The chemical composition of groundwater is often complex, but groundwater in specific aquifers often has specific fingerprints. Specific geological and hydrogeological conditions determine the chemical characteristics of groundwater. Many factors in nature can lead to specific chemical characteristics of groundwater. Such as the lithology of the aquifer, the climatic characteristics of the recharge zone, the hydrodynamic characteristics of the groundwater, and so on. These conditions constitute the environmental characteristics of the groundwater. After comprehensively analyzing the hydrogeological conditions of the aquifer, studying the water chemistry characteristics of the groundwater sample can determine the source of groundwater that flows into the mine during the coal mining process. [1-12].

Judging the chemical composition of groundwater often requires a large amount of knowledge of water chemistry, and only true water chemists can accurately determine the geological environment in which groundwater is located. However, for coal mining, it is not necessary to spend a lot of time and money on the study of groundwater chemical mechanism. In order to quickly and easily find out where the groundwater flowing into the coal mine comes from, hydrogeologists often cluster the water chemistry indicators of groundwater samples. This paper uses this method to study the source of water inrush from the mine in Xinshuguang Coal Mine.

2. The hydrogeology condition of Xin Shuguang coal power plant coal mine
The occurrence conditions of groundwater are controlled and influenced by many factors such as stratum lithology, geological structure, topography and hydrometeorology. Jixi City is located in the combination zone of Wandashan, Zhangguangcailing and Laoyeling. It is formed by the Yanshanian
and Mashanian tectonic processes, forming the Jixi Sag, which has created today’s tectonic and geomorphological forms, and thus controlled the formation of groundwater. According to general terrain conditions, geological conditions and hydrogeological conditions, the area is divided into four relatively independent and interrelated hydrogeological units, namely: hydrogeological unit in the valley plain area, hydrogeological unit in the hilly area, hydrogeological unit in the basalt platform and Middle and low mountain hydrogeological unit composed of granite.

The mining area is located in the alluvial plain of the Mulung River valley and the valley between the mountains. The aquifer is mainly composed of the Holocene and the Upper Pleistocene strata. The groundwater is mainly contained in the alluvial sand and gravel layer in the lower part of the valley plain, and forms a unified aquifer rock with the overlying silty sub-clay, humus and sub-sand. Due to the influence of neotectonic movement and flow, the distribution range and thickness of the aquifer and the thickness of the lithological particles are significantly different. Generally, the upstream particles are thicker than the downstream particles, and the thickness is thinner; the trailing edge of the terrace is thinner than the leading edge and the thickness is also thin. The alluvial sand and gravel layer in the upper reaches of the river has a narrow distribution and small thickness, but it has strong water permeability, good water-richness, good water quality and close connection with river water. It is a good aquifer. The terraces on both sides of the river in the middle reaches of the river develop. The composition of different terraces is different, and the water-rich strength also has corresponding changes. Because the high-order areas are usually ancient alluvial, alluvial, and even bedrock, they are generally poor water areas. The low-order ground is composed of alluvial layers of modern rivers, generally rich water areas.

3. Groundwater source cluster analysis

The most common cations in groundwater are: \( \text{Na}^+ \), \( \text{K}^+ \), \( \text{Ca}^{2+} \), \( \text{Mg}^{2+} \). The most common anions are: \( \text{Cl}^- \), \( \text{SO}_4^{2-} \), \( \text{HCO}_3^- \). Although there are many other intermediate ions present, their content is often negligible relative to these most common anions and cations. Therefore, the fingerprint of the groundwater sample can be roughly determined by measuring the percentage of the most common anion and cation content in groundwater. By comparing the fingerprints of the water samples of the aquifers in the coal mining area with the fingerprints of the mine water samples, it can be determined from which aquifer that the groundwater flowing into the mine comes from. Cluster analysis can quantify this type of research and is therefore often used in the identification of water sources in mines.

In this paper, the chemical constituents of anion and cation in the eight water Accord of Xinshuguang Coal Mine were analyzed, and the source of water inrush from mine was judged by cluster analysis. These water samples were taken from different collection points, and all samples were collected in 2011. During the construction and mining of the mine, there was no significant change in groundwater hydraulic conditions.

| ID | Sample type         | Sample ID | Location          | Cluster type |
|----|---------------------|-----------|-------------------|--------------|
| 1  | Mine water          | 2010-W-111| Wuchuan Main Belt Roadway | A            |
| 2  | Mine water          | 2010-W-112| Wuchuan Main Belt Roadway | A            |
| 3  | Mine water          | 2010-W-113| Alkali Field Main Belt Roadway | C            |
| 4  | Groundwater in Quaternary | J2-2  | NO.1 spring in Mulin | B            |
| 5  | Groundwater in Quaternary | J2-3  | NO.2 spring in Jicaihe | B            |
| 6  | Groundwater in Quaternary | J2-7  | Supply well in wanmu village | D            |
| 7  | Groundwater in Ordovician limestone | Q2-3 | Borehole O1 | C            |
| 8  | Groundwater in Ordovician limestone | Q2-4 | Borehole O2 | C            |

In this paper, the samples were classified by cluster analysis. The classification results are shown in Figure 1.
4. Result analysis

As can be seen from Figure 1, the eight samples tested in this test were divided into four groups. The specific results are as follows:

1) A group of samples from the XXY laneway, where the results of sample 12 are very similar, reflecting the same source;

2) Group B samples are samples No. 4 and No. 5, it can be seen that their water chemical composition is very similar to that of the sputum group samples, indicating that the water source of the group B sample is very close to the water source of the sputum group, and may even come from the same aquifer, only due to The different routes of seepage make a slight difference in their chemical composition;

3) Group C water samples include water samples No. 7, 8, and 3. It is presumed that the water samples No. 7, 8, and 3 should be from the same aquifer, and their water chemical composition is not complicated, indicating the flow path through which they flow. not long.

In addition, Figures 2, 3, 4, and 5 show the water chemistry characteristics of No. 1, 2, and 3 water samples. By comparison, it can be seen that the water samples 1 and 2 are similar and similar.
Figure 3. Ion pie chart of 2010-W-111.

Figure 4. Ion pie chart of 2010-W-112.

Figure 5. Ion pie chart of 2010-W-113.

In the Figure 2, 2010-W-111 and 2010-W-112 different from 2010-W-113 significant. Compare the Ion pie chart in Figure 3,4,5 can has the same conclusion.

5. Conclusion
After hierarchical clustering analysis, we found that the water samples 2010-water-111 and 2010-water-112 collected from the Wuchuan main transport belt were classified into the first cluster. The main transport belt of the alkali field and the surrounding water source are obviously not homologous to the water in the mine. The alkali transport main belt has direct hydraulic connection with limestone water.

Acknowledgments
This research was supported by projects from national natural science foundation of China (NO.41602254), and Special Funding Project for Basic Scientific Research Business Fees of Central Universities (2452016179), Double-class discipline group dry area hydrology and water resources regulation research funding project (Z102021853).

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