Carboniferous-Permian age, including Benxi Formation, Taiyuan Formation and Shanxi Formation from below to above. There are three major coal seams, named Coal Seam 9, Coal Seam 5 and Coal Seam 2 from below to above. Coal Seams 9 and 5 belong to the Taiyuan Formation of Late Carboniferous age, and Coal Seam 2 belongs to the Shanxi Formation of Early Permian age. The paleogeography of the Taiyuan Formation are shallow sea facies and transitional facies (Dai *et al.*, 2002).

The Taiyuan Formation in the Gequan Coal Mine consists of sandstone, siltstone, mudstone, limestone and coal beds, with a thickness between 130.28 m and 181.00 m, 153.74 m in average. The Seam 5 is in the middle portion of the Taiyuan Formation. Its thickness vary between 0.40 m and 3.02 m, 1.51 m in average.

3. Experimental methods

Five bench samples were collected from Coal Seam 5 in Gequan Coal Mine, following the Chinese Standard Method GB 482-1995. In order to detect the difference geochemistry of REE in different horizons but in the same coalbed, five samples were collected from the top, middle and bottom of Seam 5, respectively, which consists of three coal samples, one roof rock sample and one floor rock sample. The samples were 10 cm wide and 10 cm deep. All caly partings thicker than 30 mm were excluded. From the top to bottom, the five samples were labeled GQ-R, GQ-T, GQ-M, GQ-B and GQ-F.

The samples were crushed and ground to less than 200 for geochemical analysis. The concentrations of fifteen rare earth elements (Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu) were determined by inductively coupled plasma-mass spectroscopy (ICP-MS) (Benabid *et al.*, 2007). The chondrite-normalized uses the average of 6 chondrites which was put forward by Masuda (Masuda *et al.*, 2002).

4. Results and discussion

4.1. Parameters

The geochemical parameters about REE are calculated according to data in Table 1. The results show that the ∑REE (Y+ La+ Ce+ Pr+ Nd+ Sm+ Eu+ Gd+ Tb+ Dy+ Ho+ Er+ Tm+ Yb + Lu) are between 23.41 and 343.76 μg/g, and 205.02 μg/g in average. The LREE (Y+La+ Ce+ Pr+ Nd+ Sm+ Eu) are 20.53-317.76 μg/g, and 189.69 μg/g in average. The HREE (Gd+ Tb+ Dy+ Ho+ Er+ Tm+ Yb + Lu) are 2.87-25.86 μg/g, and 15.33 μg/g in average (Table 2). The LREE/HREE values are 7.15-15.43, and 11.91 in average, and is indicates the LREE are enrichment and HREE are depleted. The values of δEu are between 0.13-0.27, ansd show a clear Eu negative anomaly. The values δCe vary between1.83-4.17, and show Ce positive anomaly.

The results show a large variation in the overall concentrations of REE. The ∑REE in three coal samples are 23.41-343.76 μg/g, and 157.10 μg/g in average, and this is much higher than that of US coals (62.10μg/g, Finkelman, 1993) and global coals average (46.3 μg/g) (Valkovic, 1983). The average ∑REE in rock samples is 276.89 μg/g, and is higher than that in coal samples, also much higher than that in North American shale (173.20 μg/g).

The minimum value of ∑REE, LREE and HREE are in sample GQT, which were collected in the top of Seam 5. However, the maximum values of them are in sample GQB, which were collected in the bottom of Seam 5 at the same time. These indicate that the concentrations of ∑REE, LREE and HREE decrease from the bottom to the top of the seam. Some researchers reported that the concentration of REE is high in coals which are controlled by terrigenous supplement, but it is low in coals which are influenced by marine transgression (Zhao, 2002). ∑REE is becoming less and less from the bottom to the top. This phenomenon may indicate that the influence of marine on Seam 5 is stronger and stronger during the peat formation.

4.2 Distribution pattern

According to the data in Table 1, the distribution pattern of rare earth elements is given in Figure 1. There are three distribution patterns of rare earth elements in Gequan Mine. First pattern consists of samples GQB and GQF, and their characteristics of curves are a left high and right low arc curve. Second pattern consists of samples GQR and GQM, and their characteristics are a "V-shape" curve. Both of them are like the pattern in terrigenous clastic rocks. The last one is sample GQT, and it is like that in marine or marine bioclasts (Zhao, 2002).